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(54) **ORGANIC LIGHT-EMITTING DEVICE**

ORGANISCHE LICHTEMITTIERENDE VORRICHTUNG

DISPOSITIF ÉLECTROLUMINESCENT ORGANIQUE

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Description

BACKGROUND

1. Field

[0001] One or more embodiments relate to an organic light-emitting device.

2. Description of the Related Art

[0002] Organic light-emitting devices are self-emission devices that produce fullcolor images, and also have wide viewing angles, high contrast ratios, short response times, and excellent characteristics in terms of brightness, driving voltage, and response speed, compared to related devices in the art.

[0003] An example of such organic light-emitting devices may include a first electrode disposed on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. Carriers, such as holes and electrons, recombine in the emission layer to produce excitons. These excitons transit from an excited state to a ground state, thereby generating light.

[0004] US 2017/358761 A1 discloses compounds that are photoluminescent and electroluminescent. US 2005/227112 A1 discloses an electroluminescent element having at least one organic layer including a luminescent layer between a pair of electrodes. WO 2010/079051 A1 discloses silyl and heteroatom substituted compounds, selected from carbazoles, dibenzofurans, dibenzothiophenes and disilylbenzophospholes.

SUMMARY

[0005] Aspects of the present disclosure are directed toward an organic light-emitting device as described in independent claim 1.

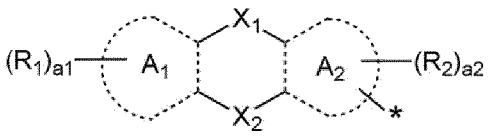
[0006] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0007] According to an embodiment (not forming part of the claimed invention), an organic light-emitting device includes:

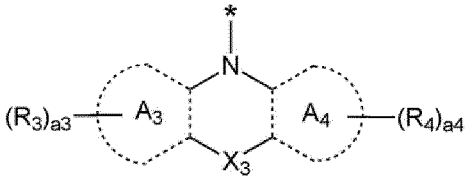
a first electrode;
a second electrode facing the first electrode; and
an organic layer between the first electrode and the second electrode and including an emission layer,
wherein the organic layer further includes a first compound represented by Formula 1 and a second compound represented by Formula 2:

Formula 1 $(CY_1)_{m1}$-$(L_1)_{b1}$-$(CY_2)_{m2}$

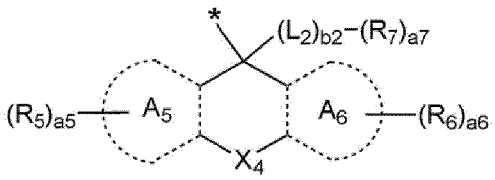
Formula 1-1



Formula 1-2



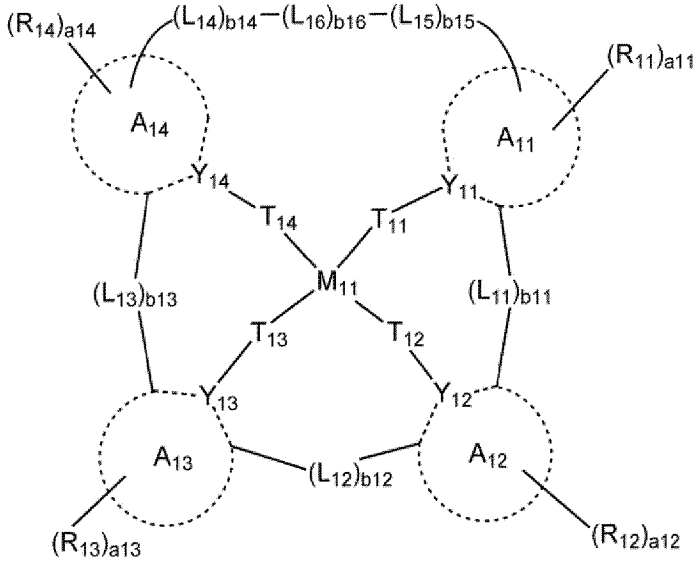
Formula 1-3



[0008] In Formulae 1, 1-1, 1-2, and 1-3,

CY_1 and CY_2 are each independently a group represented by one of Formulae 1-1, 1-2, and 1-3,
m1 and m2 are each independently 0, 1, or 2, wherein the sum of m1 and m2 is 2,
L_1 and L_2 are each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{16} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-C_{60} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group, and $-Si(Q_1)(Q_2)-$,
b1 is an integer of 0 to 5,
b2 is an integer of 0 to 4,
X_1 to X_4 are each independently selected from a single bond, *-O-*, *-S-*, $*-C(R_8)(R_9)-*'$, *-C(=O)-*', $*-B(R_8)(R_9)-*'$, $*-N(R_8)-*'$, $*-P(R_8)-*'$, and $*-Si(R_8)(R_9)-*'$,
rings A_1 to A_6 are each independently a C_5-C_{60} carbocyclic group or a C_2-C_{60} heterocyclic group,
R_1 to R_9 are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1-C_{60} alkyl group, a substituted or unsubstituted C_2-C_{60} alkenyl group, a substituted or unsubstituted C_2-C_{60} alkynyl group, a substituted or unsubstituted C_1-C_{60} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, $-Si(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, $-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$, and $-P(=S)(Q_1)(Q_2)$,
a1 to a7 are each independently an integer from 1 to 8, and

Formula 2



,

wherein, in Formula 2,

M_{11} is selected from platinum (Pt), palladium (Pd), copper (Cu), silver (Ag), gold (Au), rhodium (Rh), iridium (Ir), ruthenium (Ru), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), and thulium (Tm),
A_{11} to A_{14} are each independently selected from a C_5-C_{60} carbocyclic group and a C_1-C_{60} heterocyclic group,
Y_{11} to Y_{14} are each independently nitrogen (N) or carbon (C),

T_{11} to T_{14} are each independently selected from a single bond, oxygen (O), and sulfur (S),
L_{11} to L_{13} are each independently selected from a single bond, *-O-*', *-S-*', *-C(R_{15})(R_{16})-*', *-C(R_{15})=*', *=C(R_{15})-*', *-C(R_{15})=C(R_{16})-*', *-C(=O)-*', *-C(=S)-*', *-C≡C-*', *-B(R_{15})-*', *-N(R_{15})-*', *-P(R_{15})-*', *-Si(R_{15})(R_{16})-*', *-P(=O)(R_{15})(R_{16})-*', and *-Ge(R_{15})(R_{16})-*',
b11 to b13 are each independently an integer from 0 to 3,
when b11 is 0, A_{11} and A_{12} are not linked to each other, when b12 is 0, A_{12} and A_{13} are not linked to each other, and when b13 is 0, A_{13} and A_{14} are not linked to each other,
L_{14} to L_{16} are each independently selected from *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{17})-*', *-N(R_{17})-*', *-P(R_{17})-*', *-Si(R_{17})(R_{18})-*', *-P(=O)(R_{17})(R_{18})-*', *-Ge(R_{17})(R_{18})-*', a divalent C_2-C_{20} hydrocarbon group, a divalent C_5-C_{60} carbocyclic group, and a divalent C_1-C_{60} heterocyclic group,
b14 and b15 are each independently an integer from 1 to 5,
b16 is an integer from 0 to 5,
when b16 is 0, L_{16} is a single bond,
R_{11} to R_{18} are each independently selected from hydrogen, deuterium, -F, - Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{60} alkyl group, a substituted or unsubstituted C_2-C_{60} alkenyl group, a substituted or unsubstituted C_2-C_{60} alkynyl group, a substituted or unsubstituted C_1-C_{60} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted C_1-C_{60} heteroaryloxy group, a substituted or unsubstituted C_1-C_{60} heteroarylthio group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_1)(Q_2)(Q_3), - B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2), and -P(=S)(Q_1)(Q_2),
R_{15} and R_{11}; R_{15} and R_{12}; R_{15} and R_{13}; or R_{15} and R_{14} are optionally linked to form a substituted or unsubstituted C_5-C_{60} carbocyclic group or a substituted or unsubstituted C_1-C_{60} heterocyclic group,
a11 to a14 are each independently an integer from 1 to 8,
* and *' each indicate a binding site to a neighboring atom,
at least one substituent of the substituted C_3-C_{10} cycloalkylene group, the substituted C_1-C_{10} heterocycloalkylene group, the substituted C_3-C_{10} cycloalkenylene group, the substituted C_1-C_{10} heterocycloalkenylene group, the substituted C_6-C_{60} arylene group, the substituted C_1-C_{60} heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C_1-C_{60} alkyl group, the substituted C_2-C_{60} alkenyl group, the substituted C_2-C_{60} alkynyl group, the substituted C_1-C_{60} alkoxy group, the substituted C_3-C_{16} cycloalkyl group, the substituted C_1-C_{10} heterocycloalkyl group, the substituted C_3-C_{16} cycloalkenyl group, the substituted C_1-C_{10} heterocycloalkenyl group, the substituted C_6-C_{60} aryl group, the substituted C_6-C_{60} aryloxy group, the substituted C_6-C_{60} arylthio group, the substituted C_1-C_{60} heteroaryl group, the substituted C_1-C_{60} heteroaryloxy group, the substituted C_1-C_{60} heteroarylthio group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group;
a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from deuterium, -F, - Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{11})(Q_{12})(Q_{13}), - N(Q_{11})(Q_{12}), -B(Q_{11})(Q_{12}), -C(=O)(Q_{11}), -S(=O)$_2$(Q_{11}), and -P(=O)(Q_{11})(Q_{12});
a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;
a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent

non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group (wherein a carbazolyl group in the monovalent non-aromatic condensed heteropolycyclic group is excluded), $-Si(Q_{21})(Q_{22})(Q_{23})$, $-N(Q_{21})(Q_{22})$, $-B(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, and $-P(=O)(Q_{21})(Q_{22})$; and

$-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$, and $-P(=O)(Q_{31})(Q_{32})$, and

Q_1 **to** Q_3, Q_{11} to Q_{13}, Q_{21} to Q_{23}, and Q_{31} to Q_{33} are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryl group substituted with a C_1-C_{60} alkyl group, a C_6-C_{60} aryl group substituted with a C_6-C_{60} aryl group, a terphenyl group, a C_1-C_{60} heteroaryl group, a C_1-C_{60} heteroaryl group substituted with a C_1-C_{60} alkyl group, a C_1-C_{60} heteroaryl group substituted with a C_6-C_{60} aryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0009] According to another embodiment, a flat-panel display apparatus includes: a thin film transistor including a source electrode, a drain electrode, and an active layer; and the organic light-emitting device described above, wherein the first electrode of the organic light-emitting device is electrically connected to one of the source electrode and the drain electrode of the thin film transistor.

[0010] At least some of the above and other features of the invention are set out in the claims.

BRIEF DESCRIPTION OF THE DRAWING

[0011] These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the drawing (Fig. 1), which is a schematic view of an organic light-emitting device according to an embodiment.

DETAILED DESCRIPTION

[0012] Reference will now be made in more detail to embodiments, examples of which are illustrated in the accompanying drawing, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the drawing, to explain aspects of the present description. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0013] Throughout the description, the term "ring" and "group" are interchangeably used in describing cyclic functional groups. For example, "a pyrene ring" is used to refer to a pyrene group, and vice versa. Also, any numerical range recited herein is intended to include all sub-ranges of the same numerical precision subsumed within the recited range. For example, a range of "1.0 to 10.0" is intended to include all subranges between (and including) the recited minimum value of 1.0 and the recited maximum value of 10.0, that is, having a minimum value equal to or greater than 1.0 and a maximum value equal to or less than 10.0, such as, for example, 2.4 to 7.6. Any maximum numerical limitation recited herein is intended to include all lower numerical limitations subsumed therein and any minimum numerical limitation recited in this specification is intended to include all higher numerical limitations subsumed therein.

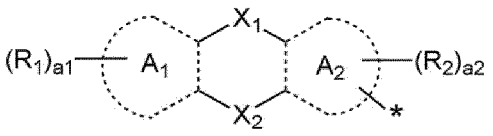
[0014] An organic light-emitting device according to an embodiment includes: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode and including an emission layer,

wherein the emission layer comprises a host and a dopant, the host comprises a first compound represented by Formula 1 and the dopant comprises a second compound represented by Formula 2A or 2B.

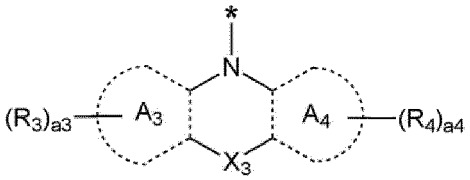
[0015] The first compound is represented by Formula 1:

Formula 1 $$(CY_1)_{m1}\text{-}(L_1)_{b1}\text{-}(CY_2)_{m2}$$

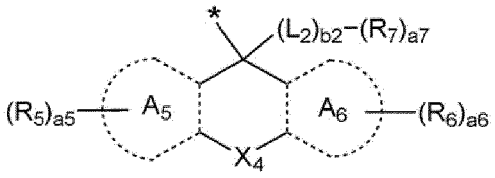
Formula 1-1



Formula 1-2



Formula 1-3



[0016] In Formulae 1, 1-1, 1-2, and 1-3, CY_1 and CY_2 are each independently a group represented by one of Formulae 1-1, 1-2, and 1-3.

[0017] m1 and m2 are each independently 0, 1, or 2, wherein the sum of m1 and m2 is 2. For example, m1 and m2 may each be 1; m1 may be 2 and m2 may be 0; or m1 may be 0 and m2 may be 2.

[0018] In Formulae 1, 1-1, 1-2, and 1-3, L_1 and L_2 are each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylene group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group, and - $Si(Q_1)(Q_2)$-.

[0019] In one embodiment, L_1 and L_2 may each independently be selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a pyrazolylene group, an imidazolylene group, an oxazolylene group, an isoxazolylene group, a thiazolylene group, an isothiazolylene group, an oxadiazolylene group, a thiadiazolylene group, a dithiazolylene group, a carbazolylene group, and a triazinylene group;

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

-$Si(Q_4)(Q_5)$-, and

Q_4 and Q_5 may each independently be selected from:

a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and

a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0020] In one embodiment, L_1 and L_2 may each independently be selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group;

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

$-Si(Q_4)(Q_5)-$, and

Q_4 and Q_5 may each independently be selected from:

a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and

a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0021] For example, L_1 may be selected from:

a phenylene group, a pyridinylene group, and a pyrazolylene group;

a phenylene group, a pyridinylene group, and a pyrazolylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} (*e.g.* C_1-C_{10}) alkyl group, a C_1-C_{20} (*e.g.* C_1-C_{10}) alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group; and

$-Si(Q_4)(Q_5)-$, and

Q_4 and Q_5 may each independently be selected from:

a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and

a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with a C_1-C_{10} alkyl group.

[0022] In Formulae 1, 1-1, 1-2, and 1-3, b1 and b2 may each independently be an integer from 0 to 5. For example, b1 may be an integer from 0 to 5. For example, b2 may be an integer from 0 to 4. For example, b1 and b2 may each independently be 0, 1, 2, or 3.

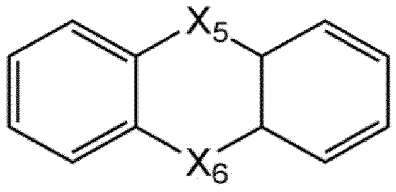
[0023] In Formulae 1-1, 1-2, and 1-3, X_1 to X_4 may each independently be selected from a single bond, *-O-*, *-S-*, $*-C(R_8)(R_9)-*'$, *-C(=O)-*', $*-B(R_8)(R_9)-*'$, $*-N(R_8)-*'$, $*-P(R_8)-*'$, and $*-Si(R_8)(R_9)-*'$.

[0024] In Formulae 1-1, 1-2, and 1-3, X_1 to X_4 may each independently be selected from *-O-*, *-S-*, $*-C(R_8)(R_9)-*'$, *-C(=O)-*', $*-B(R_8)(R_9)-*'$, $*-N(R_8)-*'$, $*-P(R_8)-*'$, and $*-Si(R_8)(R_9)-*'$.

[0025] In Formulae 1-1, 1-2, and 1-3, A_1 to A_6 are each independently a C_5-C_{60} carbocyclic group or a C_2-C_{60} heterocyclic group. For example, in Formulae 1-1, 1-2, and 1-3, A_1 to A_6 may each independently be a C_5-C_{30} carbocyclic group or a C_2-C_{20} heterocyclic group. For example, in Formulae 1-1, 1-2, and 1-3, A_1 to A_6 may each independently be a C_5-C_{20} carbocyclic group or a C_2-C_{20} heterocyclic group. For example, in Formulae 1-1, 1-2, and 1-3, A_1 to A_6 may each independently be a C_6-C_{16} carbocyclic group or a C_3-C_{12} heterocyclic group.

[0026] In one embodiment, A_1 to A_6 may each independently be selected from a benzene ring, a naphthalene ring, a pyridine ring, a pyrimidine ring, a pyrazine ring, a pyridazine ring, a triazine ring, a quinoline ring, an isoquinoline ring, a quinoxaline ring, a quinazoline ring, and a ring represented by Formula 4:

Formula 4

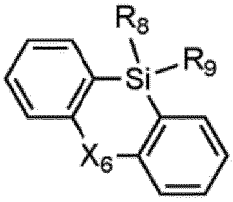


[0027] In Formula 4,

X_5 and X_6 are each independently selected from *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_8)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*', and *-Si(R_8)(R_9)-*', and
R_8 and R_9 are the same as described in connection with R_8 and R_9 in Formulae 1-1 to 1-3.

[0028] For example, A_1 to A_5 may each independently be selected from a benzene ring, a naphthalene ring, a pyridine ring, a pyrimidine ring, a pyrazine ring, a pyridazine ring, and a triazine ring, and
A_6 may be selected from a benzene ring, a pyridine ring, and a ring represented by Formula 4-1:

Formula 4-1



[0029] In Formula 4-1,

X_6 may be *-O-* or *-S-*,
R_8 and R_9 may respectively be defined the same as R_8 and R_9 in Formulae 1-1 to 1-3.

[0030] For example, A_1 to A_3, A_5 and A_6 may each independently be selected from a benzene ring, a naphthalene ring, a pyridine ring, a pyrimidine ring, a pyrazine ring, a pyridazine ring, and a triazine ring, and
A_4 may be selected from a benzene ring, a pyridine ring, and a ring represented by Formula 4-1.

[0031] In Formulae 1-1, 1-2, and 1-3, R_1 to R_9 are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a substituted or unsubstituted C_3-C_{16} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_1)(Q_2)(Q_3), - B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2), and -P(=S)(Q_1)(Q_2).

[0032] In one embodiment, R_1 to R_9 may each independently be selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a

terphenyl group;
a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a terphenyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, ter-butyl group, pentyl group, an isoamyl group, a hexyl group, a C_1-C_{60} *(e.g.* C_1-C_{20}) alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a terphenyl group; and
$-Si(Q_4)(Q_5)(Q_6)$ and $-P(=O)(Q_4)(Q_5)$, and
Q_4 to Q_6 may each independently be selected from:

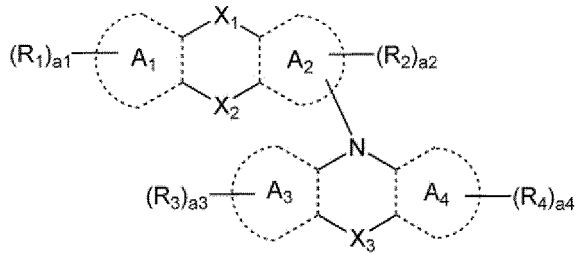
a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and
a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} (*e.g.* C_1-C_{10}) alkyl group, a C_1-C_{20} (*e.g.* C_1-C_{16}) alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0033] For example, R_1 to R_9 may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, $-Si(Q_4)(Q_5)(Q_6)$, and $-P(=O)(Q_4)(Q_5)$, and
Q_4 to Q_6 may each independently be selected from:

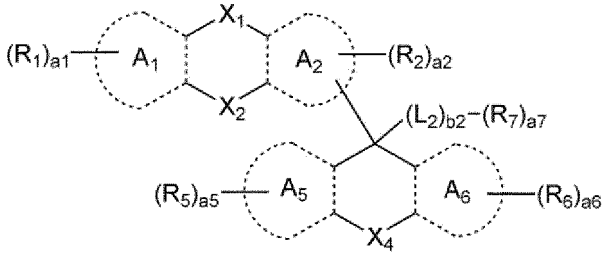
a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and
a phenyl group substituted with a C_1-C_{10} alkyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0034] In one embodiment, the first compound may a compound represented by one selected from Formulae 1A, 1B, and 1C:

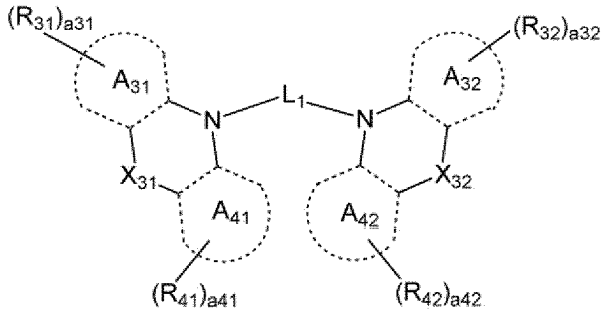
Formula 1A



Formula 1B



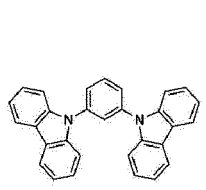
Formula 1C

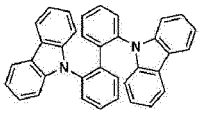


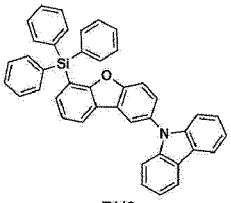
[0035] In Formulae 1A, 1B, and 1C,

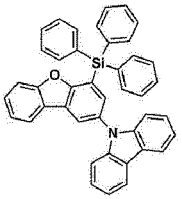
X_1 to X_4, A_1 to A_6, L_1, L_2, b2, R_1 to R_7 and a1 to a7 are the same as described herein in association with Formulae 1-1 to 1-3,
X_{31} and X_{32} are each independently the same as described in connection with X_3 in Formulae 1-1 to 1-3,
A_{31} and A_{32} are each independently the same as described in connection with A_3 in Formulae 1-1 to 1-3,
A_{41} and A_{42} are each independently the same as described in connection with A_4 in Formulae 1-1 to 1-3,
R_{31} and R_{32} are each independently the same as described in connection with R_3 in Formulae 1-1 to 1-3,
R_{41} and R_{42} are each independently the same as described in connection with R_4 in Formulae 1-1 to 1-3,
a31 and a32 are each independently the same as described in connection with a3 in Formulae 1-1 to 1-3, and
a41 and a42 are each independently the same as described in connection with a4 in Formulae 1-1 to 1-3.

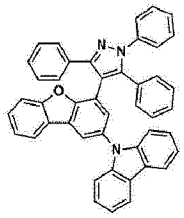
[0036] In one embodiment, the first compound may be one selected from Compounds BH2 to BH28 (compound BH1 does not form part of the claimed invention):

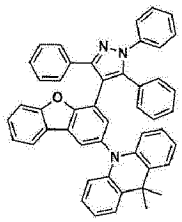

BH1

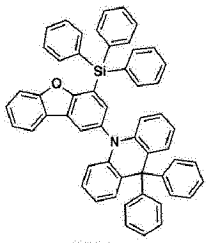

BH2

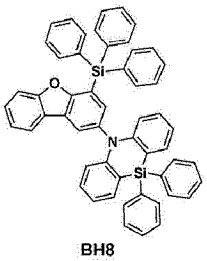

BH3

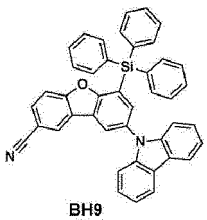

BH4

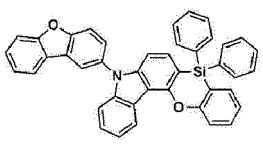

BH5

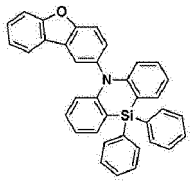

BH6

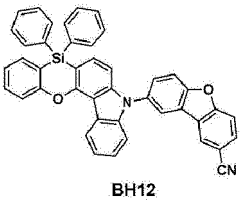

BH7

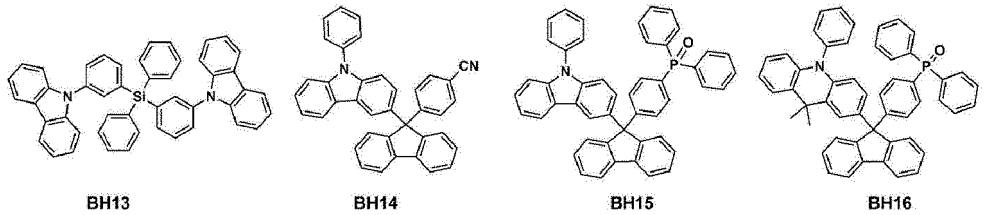

BH8

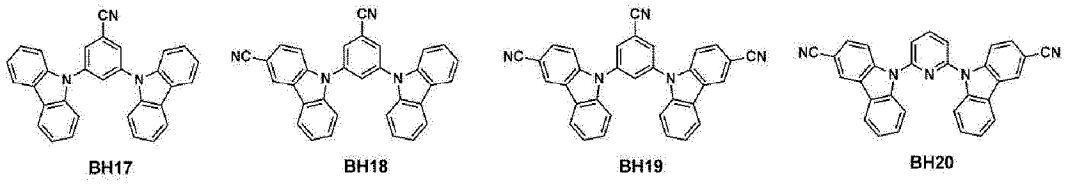

BH9

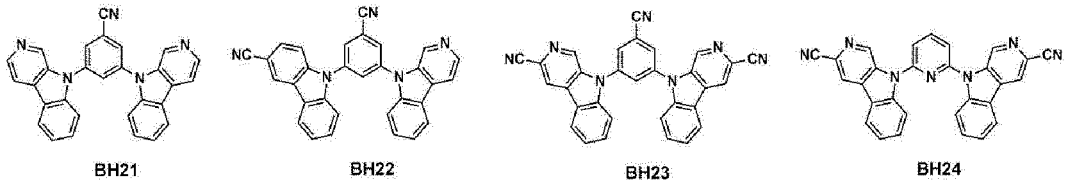

BH10

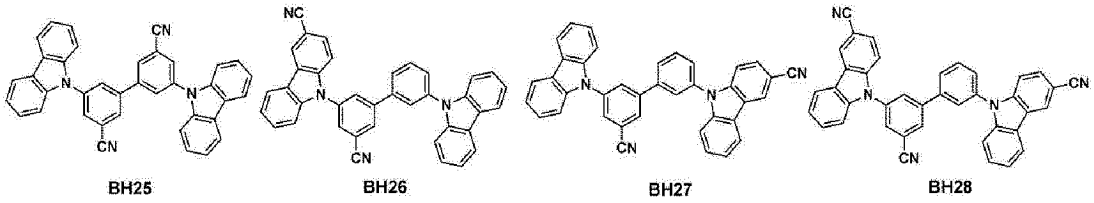

BH11


BH12





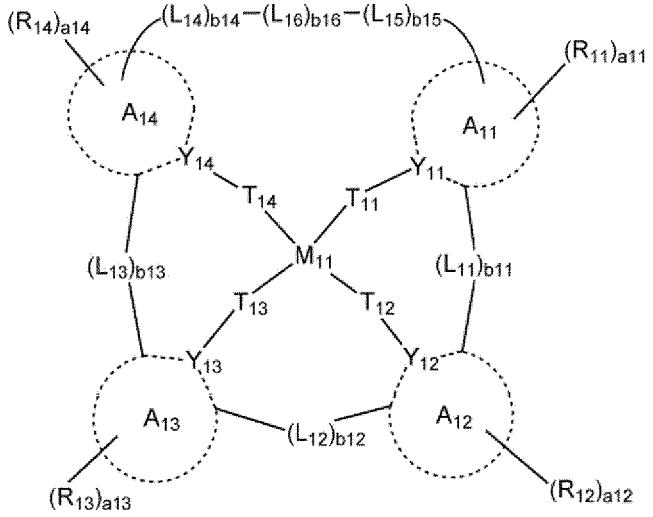




[0037] Because the first compound represented by Formula 1 may include a carbazole, dibenzofuran, dibenzothiophene, or fluorene structure, energy may be easily transferred to the second compound that is a dopant having a four-coordinate metal complex compound with high T1 energy, and a device may be configured so that the balance of electron and hole injection is well maintained, thereby increasing the lifespan and efficiency thereof.

[0038] In an embodiment not forming part of the claimed invention, the second compound is represented by Formula 2:

Formula 2



[0039] In Formula 2, M_{11} is selected from platinum (Pt), palladium (Pd), copper (Cu), silver (Ag), gold (Au), rhodium (Rh), iridium (Ir), ruthenium (Ru), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), and thulium (Tm).

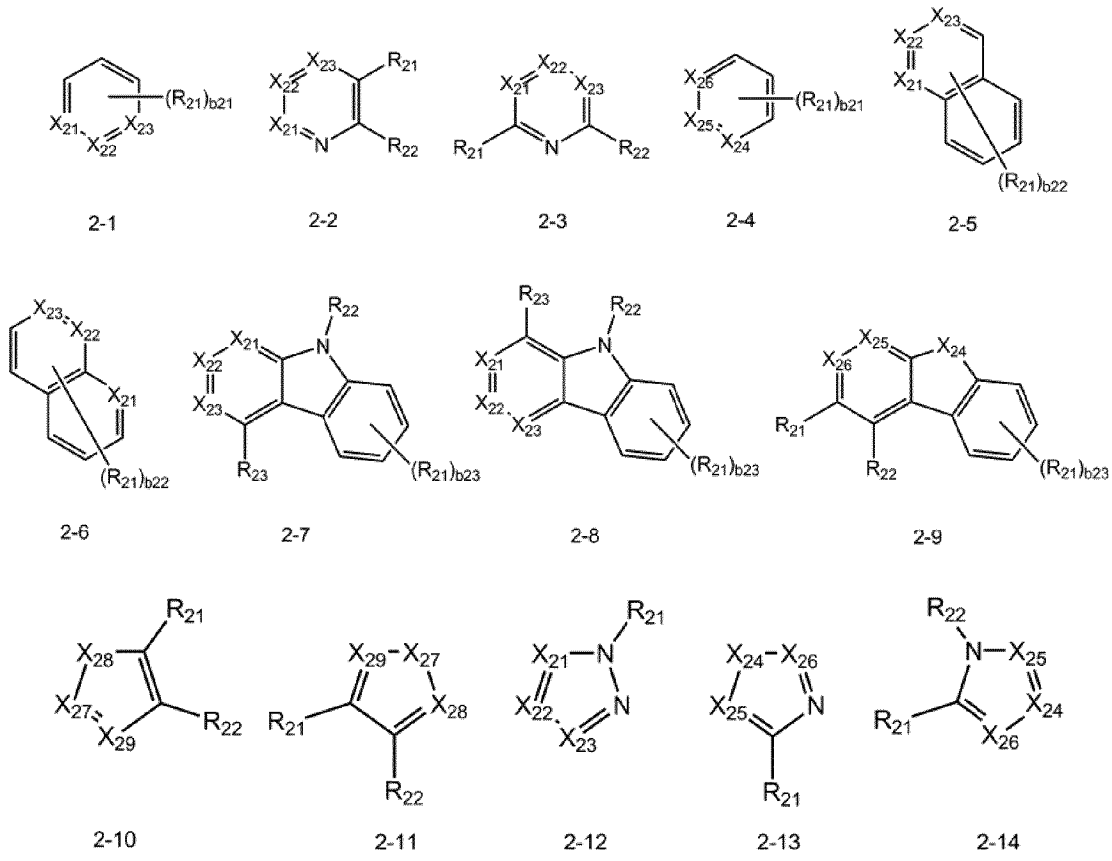
[0040] In one embodiment, in Formula 2, M_{11} may be selected from Pt, Pd, Cu, Ag, and Au.

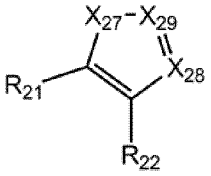
[0041] For example, in Formula 2, M_{11} may be Pt, but embodiments of the present disclosure are not limited thereto.

[0042] In Formula 2, A_{11} to A_{14} are each independently selected from a C_5-C_{60} carbocyclic group, and a C_1-C_{60} heterocyclic group. For example, in Formula 2, A_{11} to A_{14} may each independently be selected from a C_5-C_{30} carbocyclic group, and a C_1-C_{20} heterocyclic group. For example, in Formula 2, A_{11} to A_{14} may each independently be selected from a C_5-C_{20} carbocyclic group, and a C_1-C_{20} heterocyclic group.

[0043] In one embodiment, A_{11} to A_{14} may each independently be selected from a benzene ring, a naphthalene ring, an anthracene ring, a phenanthrene ring, a triphenylene ring, a pyrene ring, a chrysene ring, a cyclopentadiene ring, a 1,2,3,4-tetrahydronaphthalene ring, a furan ring, a thiophene ring, a silole ring, an indene ring, a fluorene ring, an indole ring, a carbazole ring, a benzofuran ring, a dibenzofuran ring, a benzothiophene ring, a dibenzothiophene ring, a benzosilole ring, a dibenzosilole ring, an indeno pyridine ring, an indolopyridine ring, a benzofuropyridine ring, a benzothienopyridine ring, a benzosilolopyridine ring, an indenopyrimidine ring, an indolopyrimidine ring, a benzofuropyrimidine ring, a benzothienopyrimidine ring, a benzosilolopyrimidine ring, a dihydropyridine ring, a pyridine ring, a pyrimidine ring, a pyrazine ring, a pyridazine ring, a triazine ring, a quinoline ring, an isoquinoline ring, a quinoxaline ring, a quinazoline ring, a phenanthroline ring, a pyrrole ring, a pyrazole ring, an imidazole ring, a 2,3-dihydroimidazole ring, a triazole ring, a 2,3-dihydrotriazole ring, an oxazole ring, an isoxazole ring, a thiazole ring, an isothiazole ring, an oxadiazole ring, a thiadiazole ring, a benzopyrazole ring, a benzimidazole ring, a 2,3-dihydrobenzimidazole ring, an imidazopyridine ring, a 2,3-dihydroimidazopyridine ring, an imidazopyrimidine ring, a 2,3-dihydroimidazopyrimidine ring, an imidazopyrazine ring, a 2,3-dihydroimidazopyrazine ring, a benzoxazole ring, a benzothiazole ring, a benzoxadiazole ring, a benzothiadiazole ring, a 5,6,7,8-tetrahydroisoquinoline ring, and a 5,6,7,8-tetrahydroquinoline group ring.

[0044] In one or more embodiments, A_{11} to A_{14} may each independently be represented by one selected from Formulae 2-1 to 2-43:





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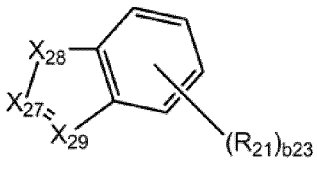

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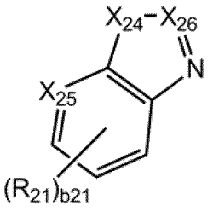

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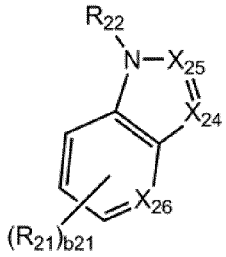

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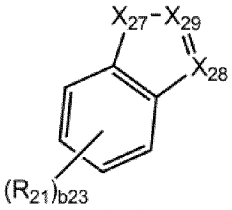

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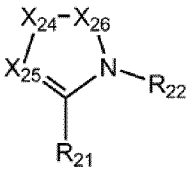

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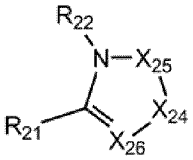

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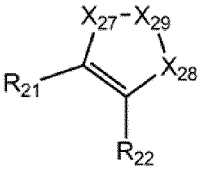

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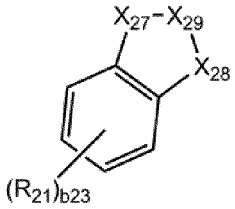

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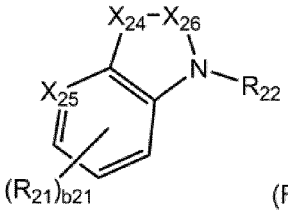

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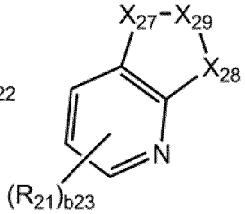

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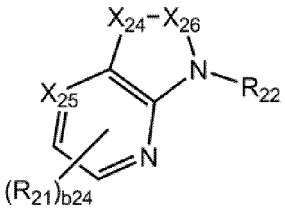

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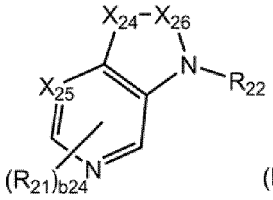

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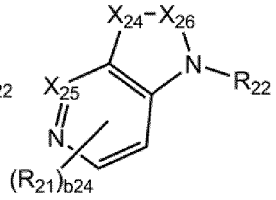

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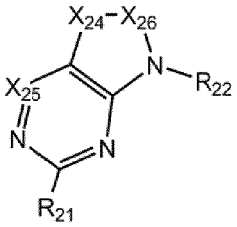

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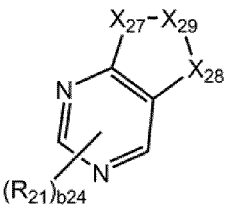

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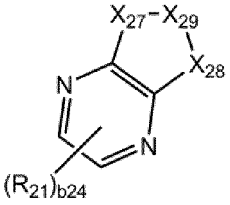

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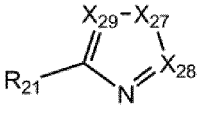

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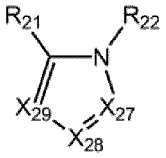

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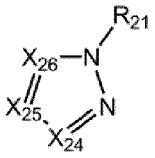

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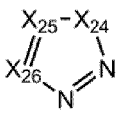

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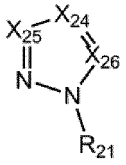

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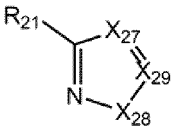

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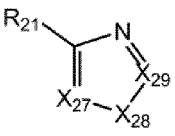

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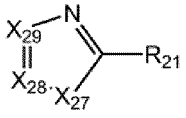

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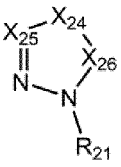

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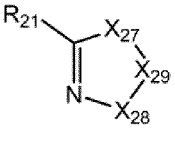

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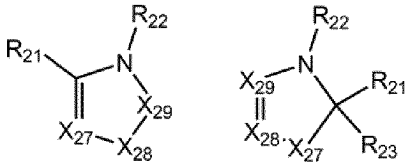


2-42 2-43

[0045] In Formulae 2-1 to 2-43,

X_{21} to X_{23} are each independently selected from $C(R_{24})$ and C-*, wherein at least two of X_{21} to X_{23} are C-*,
X_{24} is N-*, and X_{25} and X_{26} are each independently selected from $C(R_{24})$ and C-*, wherein at least one of X_{25} and X_{26} is C-*,
X_{27} and X_{28} are each independently selected from N, $N(R_{25})$, and N-*, wherein X_{29} is selected from $C(R_{24})$ and C-*, provided that i) at least one of X_{27} and X_{28} is N-* and X_{29} is C-*, or ii) X_{27} and X_{28} are each N-* and X_{29} is $C(R_{24})$,
R_{21} to R_{25} are each independently the same as described in connection with R_{11} in Formula 1,
b21 is selected from 1, 2, and 3,
b22 is selected from 1, 2, 3, 4, and 5,
b23 is selected from 1, 2, 3, and 4,
b24 is selected from 1 and 2, and
* indicates a binding site to a neighboring atom. For example, C-* represents a carbon atom in the ring structures of A_{11} to A_{14} (represented by Formulae 2-1 to 2-43) that is bonded to a neighboring atom included in a respective one of L_{11} to L_{15}.

[0046] For example, A_{11} and A_{14} in Formula 2 may each independently be selected from a pyrrole group, a pyrazole group, an imidazole group, a 2,3-dihydroimidazole group, a triazole group, and a 2,3-dihydrotriazole group, but embodiments of the present disclosure are not limited thereto.

[0047] In Formula 2, Y_{11} to Y_{14} are each independently N or C.

[0048] In one embodiment, in Formula 2,

Y_{11}, Y_{12}, and Y_{13} may each be C, and Y_{14} may be N;
Y_{11}, Y_{12}, and Y_{14} may each be C, and Y_{13} may be N;
Y_{11}, Y_{13}, and Y_{14} may each be C, and Y_{12} may be N;
Y_{12}, Y_{13}, and Y_{14} may each be C, and Y_{11} may be N;
Y_{11} and Y_{14} may each be C, and Y_{12} and Y_{13} may each be N;
Y_{11} and Y_{14} may each be N, and Y_{12} and Y_{13} may each be C;
Y_{11} and Y_{12} may each be C, and Y_{13} and Y_{14} may each be N;
Y_{11} and Y_{12} may each be N, and Y_{13} and Y_{14} may each be C;
Y_{11} and Y_{13} may each be C, and Y_{12} and Y_{14} may each be N; or
Y_{11} and Y_{13} may each be N, and Y_{12} and Y_{14} may each be C.
T_{11} to T_{14} in Formula 2 are each independently selected from a single bond, O, and S.

[0049] In one embodiment, in Formula 2,

each of T_{11} to T_{14} may be a single bond;
T_{11} may be selected from O and S, and T_{12} to T_{14} may each be a single bond;
T_{12} may be selected from O and S, and T_{11}, T_{13}, and T_{14} may each be a single bond;
T_{13} may be selected from O and S, and T_{11}, T_{12}, and T_{14} may each be a single bond; or
T_{14} may be selected from O and S, and T_{11}, T_{12}, and T_{13} may each be a single bond.

[0050] L_{11} to L_{13} in Formula 2 are each independently selected from a single bond, *-O-*', *-S-*', *-$C(R_{15})(R_{16})$-*', *-$C(R_{15})$=*', *=$C(R_{15})$-*', *-$C(R_{15})$=$C(R_{16})$-*', *-C(=O)-*', *-C(=S)-*', *-C≡C-*', *-$B(R_{15})$-*', *-$N(R_{15})$-*', *-$P(R_{15})$-*', *-$Si(R_{15})(R_{16})$-*', *-P(=O)$(R_{15})(R_{16})$-*', and *-$Ge(R_{15})(R_{16})$-*'.

[0051] In one embodiment, L_{11} to L_{13} may each independently be selected from a single bond, *-O-*', *-S-*', *-$C(R_{15})(R_{16})$-*', *-$C(R_1)$=*', *=$C(R_{15})$-*', *-$B(R_{15})$-*', *-$N(R_{15})$-*', *-$Si(R_{15})(R_{16})$-*', and *-P(=O)$(R_{15})(R_{16})$-*'.

[0052] In one or more embodiments, L_{11} may be *-$N(R_{15})$-*', *-$C(R_{15})(R_{16})$-*', or *-$Si(R_{15})(R_{16})$-*', and R_{15} and R_{11} may be linked to form a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group,

L_{11} may be *-N(R_{15})-*', *-C(R_{15})(R_{16})-*', or *-Si(R_{15})(R_{16})-*', and R_{15} and R_{12} may be linked to form a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group, or
L_{12} may be *-N(R_{15})-*', *-C(R_{15})(R_{16})-*', or *-Si(R_{15})(R_{16})-*', and R_{15} and R_{13} may be linked to form a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group.

[0053] For example, L_{11} and L_{13} in Formula 2 may each independently be a single bond. For example, L_{12} in Formula 2 may be *-O-*', *-C(R_{15})(R_{16})-*', *-B(R_{15})-*', *-N(R_{15})-*', *-Si(R_{15})(R_{16})-*' and *-P(R_{15})-*'.

[0054] In Formula 2, b11 to b13 are each independently an integer from 0 to 3,
when b11 is 0, A_{11} and A_{12} are not linked to each other, when b12 is 0, A_{12} and A_{13} are not linked to each other, and when b13 is 0, A_{13} and A_{14} are not linked to each other.

[0055] In one embodiment, b11, b12, and b13 may each independently be selected from 1, 2, and 3;

b11 may be 0, and b12 and b13 may each independently be selected from 0, 1, 2, and 3;
b12 may be 0, and b11 and b13 may each independently be selected from 0, 1, 2, and 3; or
b13 may be 0, and b11 and b12 may each independently be selected from 0, 1, 2, and 3.

[0056] In one or more embodiments, b11, b12, and b13 may each be 1;

b11 may be 0, and b12 and b13 may each independently be 0 or 1;
b12 may be 0, and b11 and b13 may each independently be 0 or 1; or
b13 may be 0, and b11 and b12 may each independently be 0 or 1.

[0057] For example, b11 may be 1, b12 may be 1, and b13 may be 1, but embodiments of the present disclosure are not limited thereto.

[0058] In Formula 2, L_{14} to L_{16} are each independently selected from *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{17})-*', *-N(R_{17})-*', *-P(R_{17})-*', *-Si(R_{17})(R_{18})-*', *-P(=O)(R_{17})(R_{18})-*', *-Ge(R_{17})(R_{18})-*', a divalent C_2-C_{20} hydrocarbon group, a divalent C_5-C_{60} (*e.g.* C_5-C_{30}) carbocyclic group, and a divalent C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group, and
b14 and b15 are each independently an integer from 1 to 5, and b16 is an integer from 0 to 5, wherein, when b16 is 0, L_{16} is a single bond.

[0059] In one embodiment, L_{14} and L_{15} may each independently be selected from *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{19})-*', *-N(R_{19})-*', *-P(R_{19})-*', *-Si(R_{19})(R_{20})-*', *-P(=O)(R_{19})(R_{20})-*''', *-Ge(R_{19})(R_{20})-*', and a divalent C_2-C_{20} hydrocarbon, and
L_{16} may be selected from a divalent C_5-C_{60} (*e.g.* C_5-C_{30}) carbocyclic group and a divalent C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group.

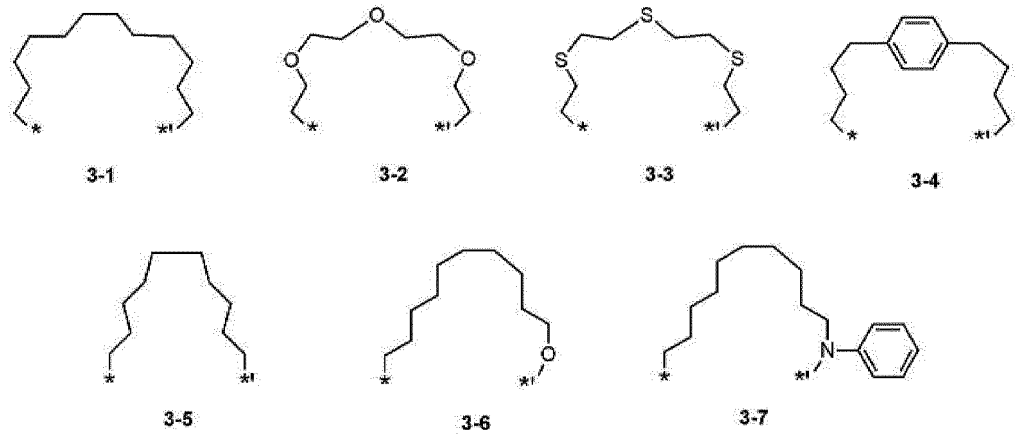
[0060] In one or more embodiments, L_{14} and L_{15} may each independently be selected from *-O-*', *-S-*', *-N(R_{19})-*', a C_2-C_{20} (*e.g.* C_2-C_{10}) alkylene group, a C_2-C_{20} (*e.g.* C_2-C_{10}) alkenylene group, and a C_2-C_{20} (*e.g.* C_2-C_{10}) alkynylene group,
R_{19} may be selected from:

a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an azulenyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group,
L_{16} may be selected from a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene

group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group; and

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group

[0061] For example, in Formula 2, a moiety represented by *-$(L_{14})_{b14}$-$(L_{16})_{b16}$-$(L_{15})_{b15}$-*' may be represented by one selected from Formulae 3-1 to 3-7:



[0062] In Formulae 3-1 to 3-7, * and *' each indicate a binding site to a neighboring atom.

[0063] In an embodiment, in Formula 2, a moiety represented by *-$(L_{14})_{b14}$-$(L_{16})_{b16}$-$(L_{15})_{b15}$-*' may be represented by one selected from Formulae 3-1 to 3-5.

[0064] In Formula 2, R_{11} to R_{20} are each independently selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryloxy group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylthio group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si$(Q_1)(Q_2)(Q_3)$, -B$(Q_1)(Q_2)$, -N$(Q_1)(Q_2)$, -P$(Q_1)(Q_2)$, -C(=O)(Q_1), -S(=O)(Q_1), -S$(=O)_2(Q_1)$, -P(=O)$(Q_1)(Q_2)$, and -P(=S)$(Q_1)(Q_2)$, R_{15} and R_{11}; R_{15} and R_{12}; R_{15} and R_{13}; or R_{15} and R_{14} are optionally be linked to form a substituted or unsubstituted C_5-C_{60} (*e.g.* C_5-C_{30}) carbocyclic group or a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group, a11 to a14 are each independently an integer from 1 to 8.

[0065] In Formula 2, * and *' each indicate a binding site to a neighboring atom.

[0066] In one embodiment, R_{11} to R_{20} may each independently be selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a cyano group, a C_1-C_{20} alkyl group, and a C_1-C_{20} alkoxy group;

a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group, each substituted with at least one selected from -F, -Cl, -Br, -I, a cyano group, a phenyl group, and a biphenyl group;

a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentacenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, a silolyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an indolyl group, an isoindolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, an isoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a benzoquinoxalinyl group, a quinazolinyl group, a benzoquinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, a benzosilolyl group, a benzothiazolyl group, a benzoisothiazolyl group, a benzoxazolyl group, a benzoisoxazolyl group, a triazolyl group, a tetrazolyl group, a thiadiazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, a benzocarbazolyl group, a naphtho benzofuranyl group, a naphtho benzothiophenyl group, a naphthobenzosilolyl group, a dibenzocarbazolyl group, a dinaphthofuranyl group, a dinaphtho thiophenyl group, a dinaphtho silolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an oxazolopyridinyl group, a thiazolopyridinyl group, a benzonaphthyridinyl group, an azafluorenyl group, an azaspiro-bifluorenyl group, an azacarbazolyl group, an azadibenzofuranyl group, an azadibenzothiophenyl group, an azadibenzosilolyl group, an indeno pyrrolyl group, an indolopyrrolyl group, an indeno carbazolyl group, and an indolocarbazolyl group;

a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentacenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, a silolyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an indolyl group, an isoindolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, an isoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a benzoquinoxalinyl group, a quinazolinyl group, a benzoquinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, a benzosilolyl group, a benzothiazolyl group, a benzoisothiazolyl group, a benzoxazolyl group, a benzoisoxazolyl group, a triazolyl group, a tetrazolyl group, a thiadiazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, a benzocarbazolyl group, a naphtho benzofuranyl group, a naphtho benzothiophenyl group, a naphthobenzosilolyl group, a dibenzocarbazolyl group, a dinaphthofuranyl group, a dinaphtho thiophenyl group, a dinaphtho silolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an oxazolopyridinyl group, a thiazolopyridinyl group, a benzonaphthyridinyl group, an azafluorenyl group, an azaspiro-bifluorenyl group, an azacarbazolyl group, an azadibenzofuranyl group, an azadibenzothiophenyl group, an azadibenzosilolyl group, an indeno pyrrolyl group, an indolopyrrolyl group, an indeno carbazolyl group, and an indolocarbazolyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a cyano group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentacenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, a silolyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an indolyl group, an isoindolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, an isoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a benzoquinoxalinyl group, a quinazolinyl group, a benzoquinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, a benzofuranyl group, a benzothiophenyl group, a benzosilolyl group, a benzothiazolyl group, a benzoisothiazolyl group, a benzoxazolyl group, a benzoisoxazolyl group, a triazolyl group, a tetrazolyl group, a thiadiazolyl group, an oxadiazolyl group, a triazinyl group, a carbazolyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a dibenzosilolyl group, a benzocarbazolyl group, a naphtho benzofuranyl group, a naphtho benzothiophenyl group, a

naphthobenzosilolyl group, a dibenzocarbazolyl group, a dinaphthofuranyl group, a dinaphtho thiophenyl group, a dinaphtho silolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an oxazolopyridinyl group, a thiazolopyridinyl group, a benzonaphthyridinyl group, an azafluorenyl group, an azaspiro-bifluorenyl group, an azacarbazolyl group, an azadibenzofuranyl group, an azadibenzothiophenyl group, an azadibenzosilolyl group, an indeno pyrrolyl group, an indolopyrrolyl group, an indeno carbazolyl group, an indolocarbazolyl group, - $Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$, - $P(=O)(Q_{31})(Q_{32})$, and $-P(=S)(Q_{31})(Q_{32})$; and

$-Si(Q_1)(Q_2)(Q_3)$, $-B(Q_1)(Q_2)$, $-N(Q_1)(Q_2)$, $-P(Q_1)(Q_2)$, $-C(=O)(Q_1)$, $-S(=O)(Q_1)$, - $S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$, and $-P(=S)(Q_1)(Q_2)$, and

Q_1 to Q_3 and Q_{31} to Q_{33} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryloxy group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylthio group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group substituted with at least one selected from deuterium, -F, and a cyano group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group substituted with at least one selected from deuterium, -F, and a cyano group, a biphenyl group, and a terphenyl group.

[0067] For example, R_{11} to R_{20} may each independently be selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a cyano group, a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, and a tert-butyl group;

a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, and a tert-butyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I and a cyano group; and

a phenyl group, a naphthyl group, and a pyridinyl group, but embodiments of the present disclosure are not limited thereto.

[0068] At least one substituent of the substituted C_3-C_{16} cycloalkylene group, the substituted C_1-C_{10} heterocycloalkylene group, the substituted C_3-C_{10} cycloalkenylene group, the substituted C_1-C_{10} heterocycloalkenylene group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylene group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, the substituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, the substituted C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, the substituted C_3-C_{16} cycloalkyl group, the substituted C_1-C_{10} heterocycloalkyl group, the substituted C_3-C_{16} cycloalkenyl group, the substituted C_1-C_{10} heterocycloalkenyl group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryloxy group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylthio group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, and a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group;

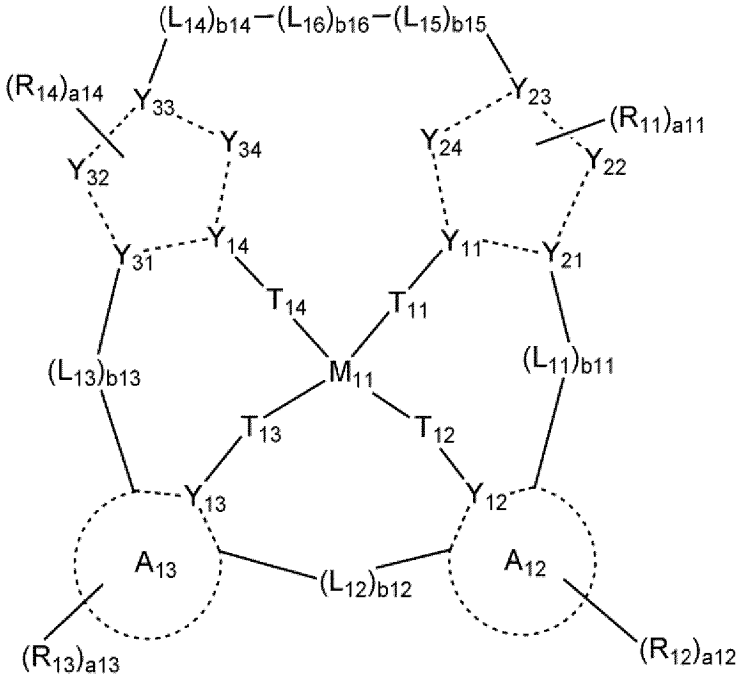
a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, and a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $-Si(Q_{11})(Q_{12})(Q_{13})$, - $N(Q_{11})(Q_{12})$, $-B(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$, and $-P(=O)(Q_{11})(Q_{12})$;

a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;

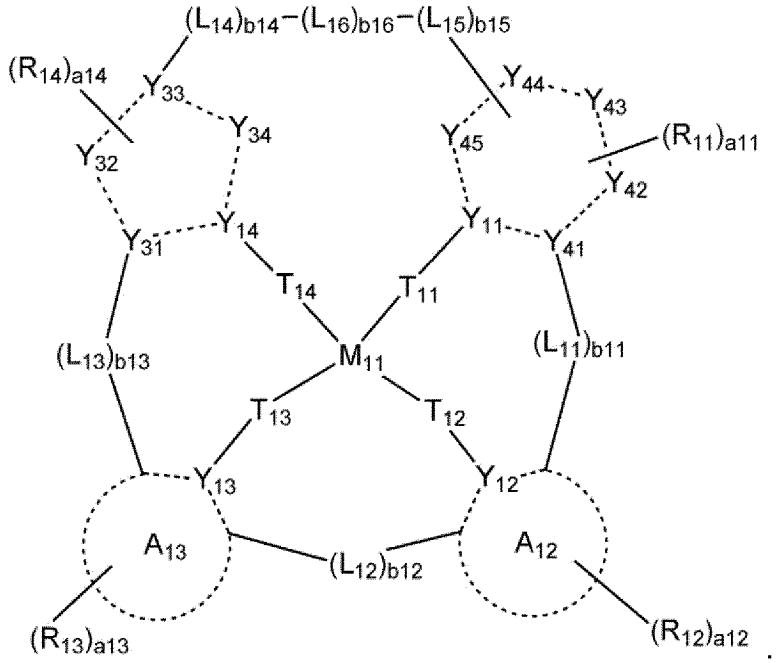
a C_3-C_{16} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{16} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group (wherein a carbazolyl group in the monovalent non-aromatic condensed heteropolycyclic group is excluded),-$Si(Q_{21})(Q_{22})(Q_{23})$, -$N(Q_{21})(Q_{22})$, -$B(Q_{21})(Q_{22})$, -$C(=O)(Q_{21})$, -$S(=O)_2(Q_{21})$, and - $P(=O)(Q_{21})(Q_{22})$; and
-$Si(Q_{31})(Q_{32})(Q_{33})$, -$N(Q_{31})(Q_{32})$, -$B(Q_{31})(Q_{32})$, -$C(=O)(Q_{31})$, -$S(=O)_2(Q_{31})$, and -$P(=O)(Q_{31})(Q_{32})$, and
Q_1 to Q_3, Q_{11} to Q_{13}, Q_{21} to Q_{23}, and Q_{31} to Q_{33} are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group substituted with a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group substituted with a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a terphenyl group, a C_1-C_{66} (*e.g.* C_1-C_{20}) heteroaryl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group substituted with a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group substituted with a C_6-C_{60} aryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0069] In an embodiment in accordance with the claimed invention, the second compound is represented by Formula 2A or 2B:

Formula 2A



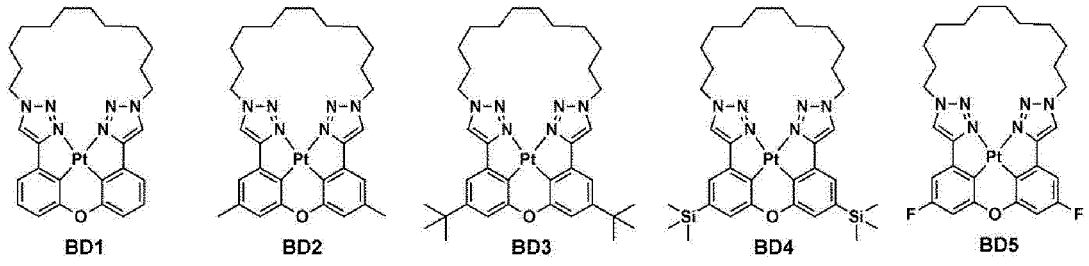
Formula 2B



[0070] In Formulae 2A and 2B,

M_{11}, A_{12}, A_{13}, Y_{11} to Y_{14}, T_{11} to T_{14}, L_{11} to L_{16}, b11 to b16, R_{11} to R_{14}, and a11 to a14 are respectively defined the same as those described above in connection with Formula 2,
Y_{21} to Y_{24} are each independently N or C,
Y_{31} to Y_{34} are each independently N or C, and
Y_{41} to Y_{45} are each independently N or C.

[0071] In one embodiment, the second compound represented by Formula 2 may be at least one compound selected from Compounds BD1 to BD25:

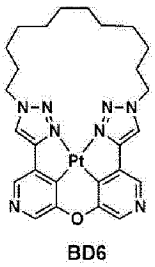

BD1

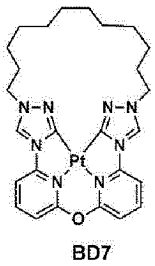
BD2

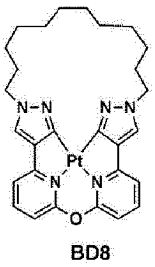
BD3

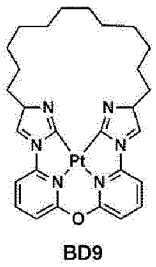
BD4

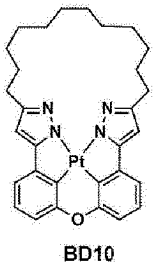
BD5

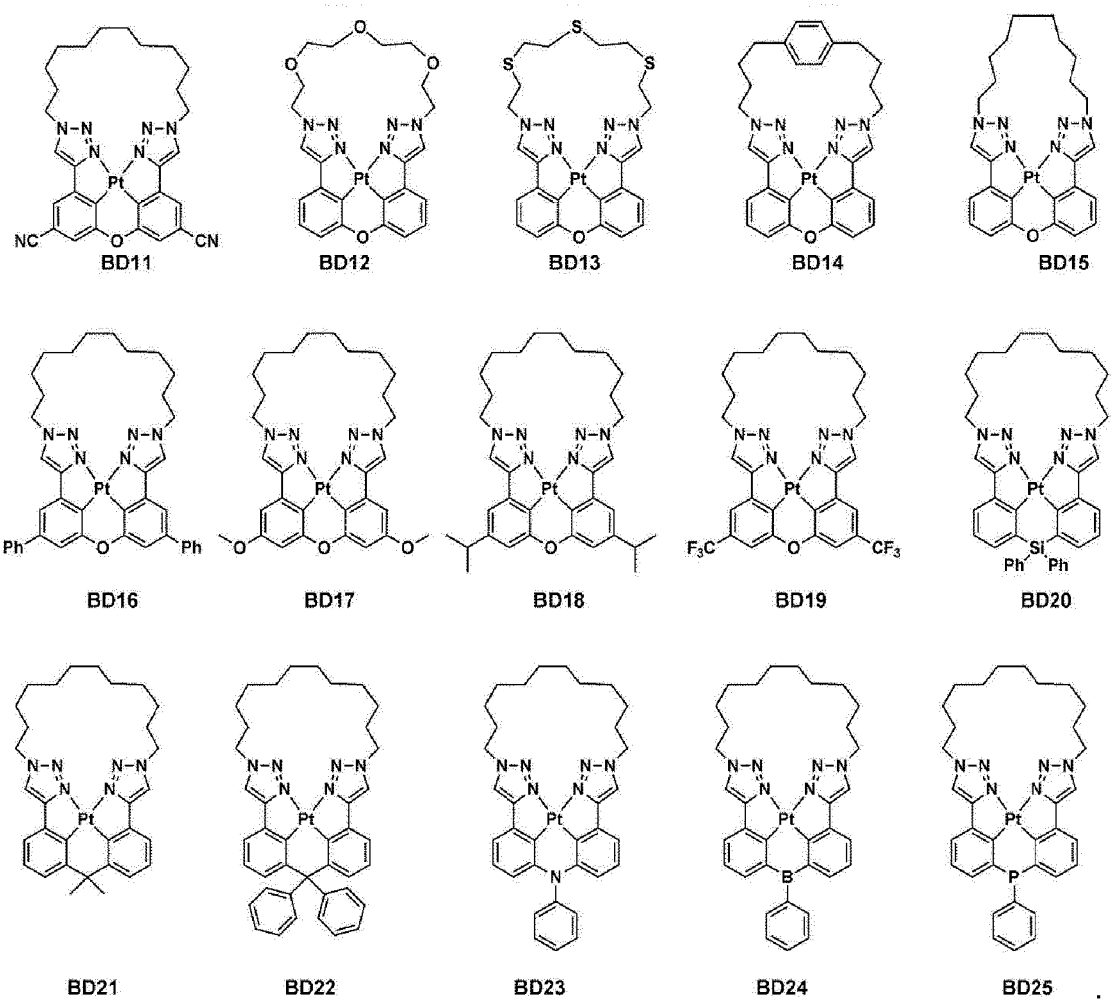

BD6


BD7


BD8


BD9


BD10



[0072] Ph in Compounds BD1 to BD25 indicates a phenyl group.

[0073] The second compound represented by Formula 2 has a structure in which A_{11} and A_{14} in Formula 2 are linked to (e.g., linked by) a moiety represented by $*-(L_{14})_{b14}-(L_{16})_{b16}-(L_{15})_{b15}-*'$. The moiety has a macrocyclic structure in which four or more carbon atoms are included in the main chain, or two or more carbon atoms and heteroatoms are included therein, thereby increasing the structural rigidity of the second compound. Although not intended to be limited by any particular theory, it is believed that interaction between metal atoms is inhibited or reduced due to the above-described structural characteristics when the second compound is included in the organic layer of the organic light-emitting device, thereby improving the stability and color purity of the organic light-emitting device.

[0074] Therefore, the organic light-emitting device including the second compound represented by Formula 2 may have a low driving voltage, high current density, and high efficiency.

[0075] In addition, the second compound may emit blue light. For example, the organometallic compound may emit blue light (bottom-emission $CIE_{x,y}$ color coordinates 0.14, 0.06 to 0.08) having a maximum emission wavelength of about 440 nm to about 495 nm, for example, a maximum emission wavelength of about 450 nm to about 471 nm, but embodiments of the present disclosure are not limited thereto. Therefore, the organometallic compound represented by Formula 2 may be usefully (e.g., suitably) utilized for manufacture an organic light-emitting device that emits deep blue light.

[0076] In one embodiment, the first compound and the second compound may each be included in the emission layer.

[0077] In one or more embodiments, the emission layer may include a host and a dopant, the host may include the first compound, and the dopant may include the second compound.

[0078] In one or more embodiments, the host may include (e.g., further include) a phosphine oxide-containing compound, and the phosphine oxide-containing compound may be different from the first compound.

[0079] In one or more embodiments, the first compound and the second compound may be included in the emission layer, and an amount of the first compound may be larger than an amount of the second compound.

[0080] In one embodiment, the first electrode may be an anode, the second electrode may be a cathode, the organic layer may further include a hole transport region between the first electrode and the emission layer and an electron transport region between the emission layer and the second electrode, the hole transport region may include at least one

selected from a hole injection layer, a hole transport layer, a buffer layer, an emission auxiliary layer, and an electron blocking layer, and the electron transport region may include at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

[0081] In one embodiment, the hole transport region may include at least one of a hole injection layer and a hole transport layer, and at least one of the hole injection layer and the hole transport layer may include a p-dopant, or (the hole transport region) may include a single film including the p-dopant.

[0082] In one or more embodiments, the electron transport region may include a hole blocking layer, and the hole blocking layer may include a phosphine oxide-containing compound and/or a silyl-containing compound.

[0083] In one embodiment, the phosphine oxide-containing compound included in the emission layer may be different from the phosphine oxide-containing compound included in the hole blocking layer.

[0084] According to another embodiment, a flat-panel display apparatus includes: a thin film transistor including a source electrode, a drain electrode, and an active layer; and the above-described organic light-emitting device, wherein the first electrode of the organic light-emitting device is electrically connected to one of the source electrode and the drain electrode of the thin film transistor.

[0085] The synthesis methods of the first compound represented by Formula 1 and the second compound represented by Formula 2 may be recognizable by those of ordinary skill in the art by referring to Examples provided below.

[0086] At least one of the first compounds represented by Formula 1 and at least one of the second compounds represented by Formula 2 are utilized between a pair of electrodes of the organic light-emitting device. For example, each of the first compound and the second compound may be included in at least one of the emission layer and the electron transport region. In addition, the first compound and the second compound may be included in one organic layer, or may be included in two different organic layers. For example, both the first compound and the second compound may be present in the emission layer; both the first compound and the second compound may be present in the electron transport region; or the first compound may be present in the emission layer, and the second compound may be present in the electron transport region, but embodiments of the present disclosure are not limited thereto.

[0087] Accordingly, there is provided an organic light-emitting device including: a first electrode; a second electrode facing the first electrode; and an organic layer between the first electrode and the second electrode, the organic layer including an emission layer, a first compound represented by Formula 1, and a second compound represented by Formula 1.

[0088] The expression "an (organic layer) includes a first compound" includes a case in which "an (organic layer) includes a first compound represented by Formula 1" and a case in which "an (organic layer) includes two or more different first compounds, each represented by Formula 1."

[0089] For example, the organic layer may include, as the first compound, only Compound BH1. In this regard, Compound BH1 exists only in the emission layer of the organic light-emitting device. In one or more embodiments, the organic layer may include, as the heterocyclic compound, Compound BH1 and Compound BH2. In this regard, Compound BH1 and Compound BH2 may exist in the same (i.e., an identical) layer (for example, Compound BH1 and Compound BH2 may both exist in an emission layer), or different layers (for example, Compound BH1 may exist in an emission layer and Compound BH2 may exist in an electron transport layer).

[0090] The expression "an (organic layer) includes a second compound" includes a case in which "an (organic layer) includes a second compound represented by Formula 2" and a case in which "an (organic layer) includes two or more different second compounds, each represented by Formula 2."

[0091] For example, the organic layer may include, as the second compound, only Compound BD1. In this regard, Compound BD1 exists only in the emission layer of the organic light-emitting device. In one or more embodiments, the organic layer may include, as the organometallic compound, Compound BD1 and Compound BD2. In this regard, Compound BD1 and Compound BD2 may exist in the same (i.e., an identical) layer (for example, Compound BD1 and Compound BD2 may both exist in an emission layer), or different layers (for example, Compound BD1 may exist in an emission layer and Compound BD2 may exist in an electron transport layer).

[0092] The term "organic layer" used herein refers to a single layer and/or a plurality of layers disposed between the first electrode and the second electrode of the organic light-emitting device. A material included in the "organic layer" is not limited to an organic material.

Description of The Drawing

[0093] The drawing is a schematic view of an organic light-emitting device 10 according to an embodiment. The organic light-emitting device 10 includes a first electrode 110, an organic layer 150, and a second electrode 190.

[0094] Hereinafter, the structure of the organic light-emitting device 10 according to an embodiment and a method of manufacturing the organic light-emitting device 10 will be described in connection with the drawing.

[0095] In the drawing, a substrate may be additionally disposed under the first electrode 110 or above the second electrode 190. The substrate may be a glass substrate or a plastic substrate, each having excellent mechanical strength,

thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

First electrode 110

[0096] The first electrode 110 may be formed by depositing or sputtering a material for forming the first electrode 110 on the substrate. When the first electrode 110 is an anode, the material for the first electrode may be selected from materials with a high work function to facilitate hole injection.

[0097] The first electrode 110 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. When the first electrode 110 is a transmissive electrode, a material for forming the first electrode may be selected from indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), zinc oxide (ZnO), and any combinations thereof, but embodiments of the present disclosure are not limited thereto. In one or more embodiments, when the first electrode 110 is a semi-transmissive electrode or a reflectable electrode, a material for forming the first electrode may be selected from magnesium (Mg), silver (Ag), aluminium (Al), aluminium-lithium (Al-Li), calcium (Ca), magnesium-indium (Mg-In), magnesium-silver (Mg-Ag), and any combinations thereof, but embodiments of the present disclosure are not limited thereto.

[0098] The first electrode 110 may have a single-layered structure, or a multi-layered structure including two or more layers. For example, the first electrode 110 may have a three-layered structure of ITO/Ag/ITO, but the structure of the first electrode 110 is not limited thereto.

[0099] The organic layer 150 is disposed on the first electrode 110. The organic layer 150 may include an emission layer.

Organic layer 150

[0100] The organic layer may 150 includes an emission layer, wherein the emission layer comprises a host and a dopant, the host comprises a first compound represented by Formula 1 and the dopant comprises a second compound represented by Formula 2A or 2B.

[0101] The organic layer 150 may further include a hole transport region between the first electrode 110 and the emission layer, and an electron transport region between the emission layer and the second electrode 190.

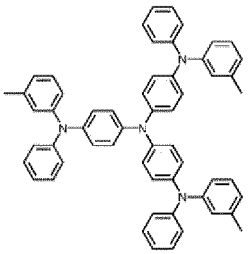
Hole transport region in organic layer 150

[0102] The hole transport region may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

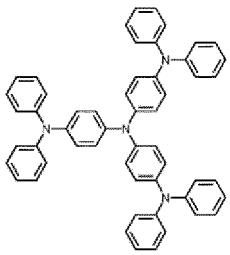
[0103] The hole transport region may include at least one layer selected from a hole injection layer, a hole transport layer, an emission auxiliary layer, and an electron blocking layer.

[0104] For example, the hole transport region may have a single-layered structure including a single layer including a plurality of different materials, or a multi-layered structure having a hole injection layer/hole transport layer structure, a hole injection layer/hole transport layer/emission auxiliary layer structure, a hole injection layer/emission auxiliary layer structure, a hole transport layer/emission auxiliary layer structure, or a hole injection layer/hole transport layer/electron blocking layer structure, wherein for each structure, constituting layers are sequentially stacked from the first electrode 110 in this stated order, but the structure of the hole transport region is not limited thereto.

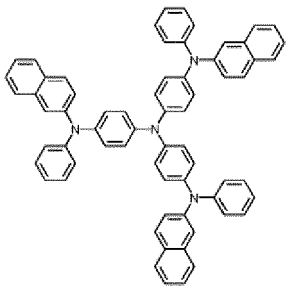
[0105] The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB (NPD), β-NPB, TPD, spiro-TPD, spiro-NPB, methylated-NPB, TAPC, HMTPD, 4,4',4"-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzenesulfonic acid (PANI/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (PANI/CSA), polyaniline/poly(4-styrenesulfonate) (PANI/PSS), a compound represented by Formula 201, and a compound represented by Formula 202:



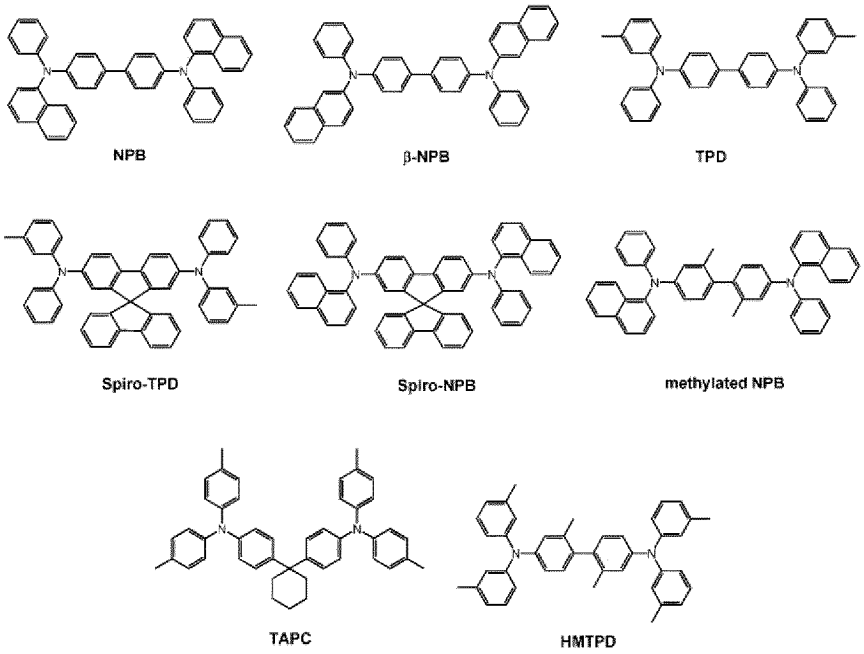
m-MTDATA



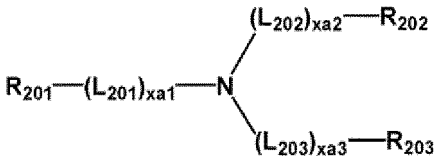
TDATA



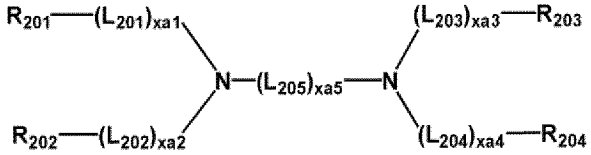
2-TNATA



Formula 201



Formula 202



[0106] In Formulae 201 and 202,

L_{201} to L_{204} may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{32}) arylene group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

L_{205} may be selected from *-O-*', *-S-*', *-N(Q_{201})-*', a substituted or unsubstituted C_1-C_{20} alkylene group, a substituted or unsubstituted C_2-C_{20} alkenylene group, a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{32}) arylene group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

xa1 to xa4 may each independently be an integer from 0 to 3,

xa5 may be an integer from 1 to 10, and

R_{201} to R_{204} and Q_{201} may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60}

(*e.g.* C_6-C_{32}) aryl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{32}) aryloxy group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{32}) arylthio group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

[0107] For example, in Formula 202, R_{201} and R_{202} may optionally be linked via a single bond, a dimethyl-methylene group, or a diphenyl-methylene group, and R_{203} and R_{204} may optionally be linked via a single bond, a dimethyl-methylene group, or a diphenyl-methylene group.

[0108] In one embodiment, in Formulae 201 and 202, L_{201} to L_{205} may each independently be selected from:

a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, an ovalenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, and a pyridinylene group; and
a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, an ovalenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, and a pyridinylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C_1-C_{10} alkyl group, a phenyl group substituted with -F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, $-Si(Q_{31})(Q_{32})(Q_{33})$, and $-N(Q_{31})(Q_{32})$, and
Q_{31} to Q_{33} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0109] In one or more embodiments, xa1 to xa4 may each independently be 0, 1, or 2.

[0110] In one or more embodiments, xa5 may be 1, 2, 3, or 4.

[0111] In one or more embodiments, R_{201} to R_{204} and Q_{201} may each independently be selected from:

a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group; and
a phenyl group, a biphenyl group, a terphenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl

group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C_1-C_{10} alkyl group, a phenyl group substituted with -F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, $-Si(Q_{31})(Q_{32})(Q_{33})$, and $-N(Q_{31})(Q_{32})$, and
Q_{31} to Q_{33} may respectively be defined the same as described above in connection with L_{201} to L_{205}.

[0112] In one or more embodiments, in Formula 201, at least one selected from R_{201} to R_{203} may each independently be selected from:

a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and
a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C_1-C_{10} alkyl group, a phenyl group substituted with -F, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;
but embodiments of the present disclosure are not limited thereto.

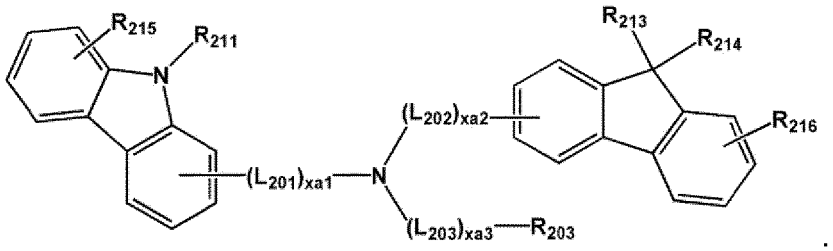
[0113] In one or more embodiments, in Formula 202, i) R_{201} and R_{202} may be linked via a single bond and/or ii) R_{203} and R_{204} may be linked via a single bond.

[0114] In one or more embodiments, in Formula 202, at least one selected from R_{201} to R_{204} may be selected from:

a carbazolyl group; and
a carbazolyl group substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C_1-C_{10} alkyl group, a phenyl group substituted with -F, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;
but embodiments of the present disclosure are not limited thereto.

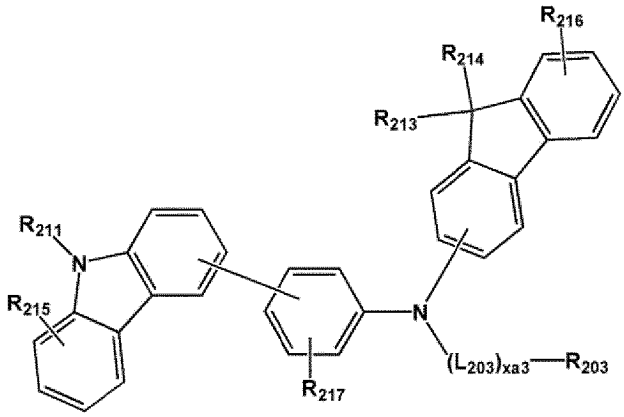
[0115] The compound represented by Formula 201 may be represented by Formula 201A:

Formula 201A



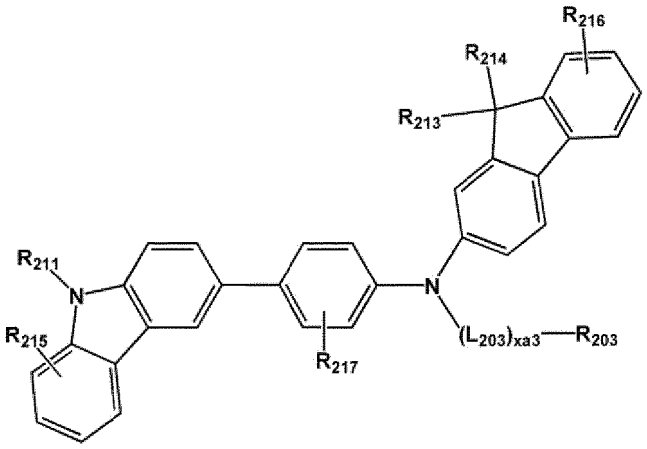
[0116] For example, the compound represented by Formula 201 may be represented by Formula 201A(1), but embodiments of the present disclosure are not limited thereto:

Formula 201A(1)



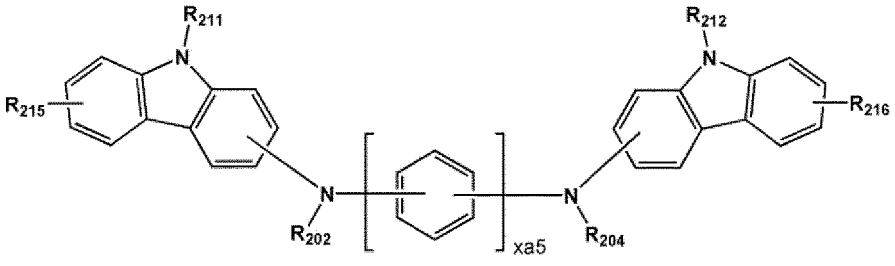
[0117] In one embodiment, the compound represented by Formula 201 may be represented by Formula 201A-1, but embodiments of the present disclosure are not limited thereto:

Formula 201A-1



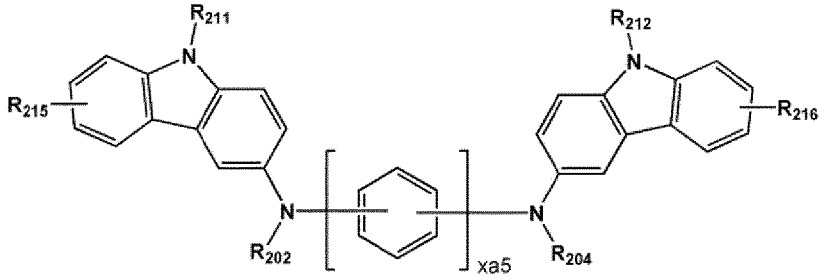
[0118] In one embodiment, the compound represented 202 by may be represented by Formula 202A:

Formula 202A



[0119] In one or more embodiments, the compound represented 202 by may be represented by Formula 202A-1:

Formula 202A-1



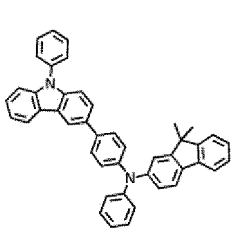
[0120] In Formulae 201A, 201A(1), 201A-1, 202A, and 202A-1,

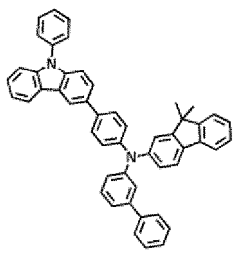
L_{201} to L_{203}, xa1 to xa3, xa5, and R_{202} to R_{204} may respectively be defined the same as described above in connection with Formulae 201 and 202,

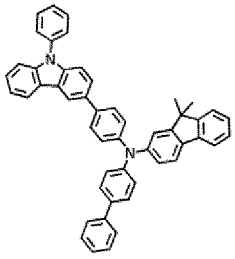
R_{211} and R_{212} may respectively be defined the same as described in connection with R_{203}.

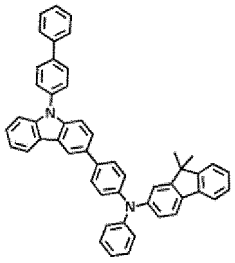
[0121] R_{213} to R_{217} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a biphenyl group, a terphenyl group, a phenyl group substituted with a C_1-C_{10} alkyl group, a phenyl group substituted with -F, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group.

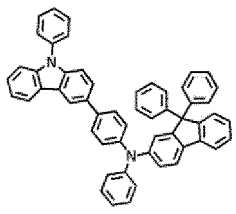
[0122] The hole transport region may include at least one compound selected from Compounds HT1 to HT39, but embodiments of the present disclosure are not limited thereto:

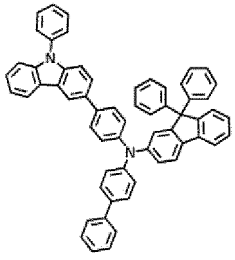

HT1

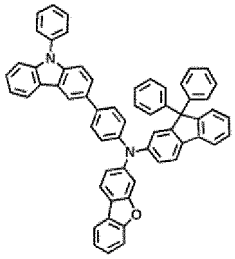

HT2


HT3

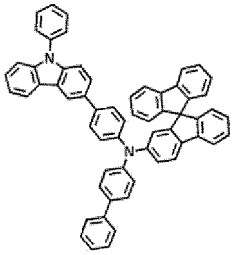

HT4


HT5

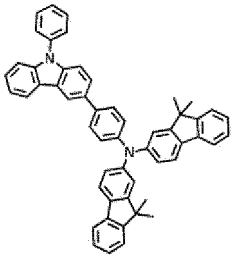

HT6



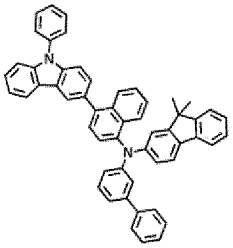
HT7



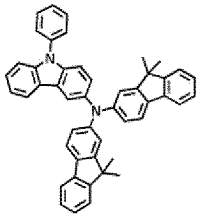
HT8



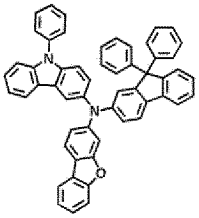
HT9



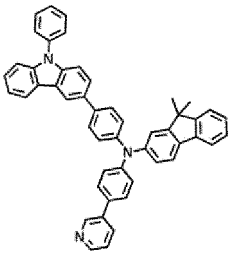
HT10



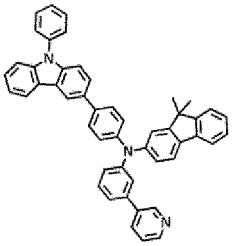
HT11



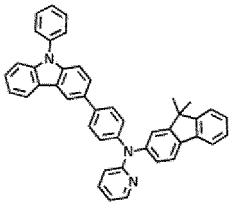
HT12



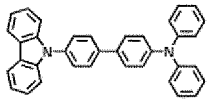
HT13



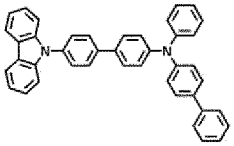
HT14



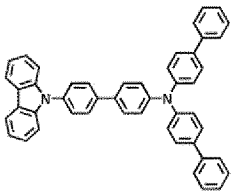
HT15



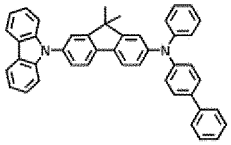
HT16



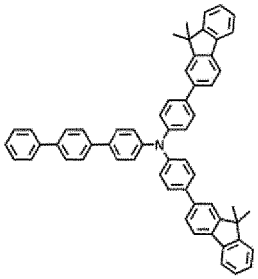
HT17



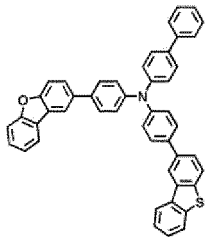
HT18



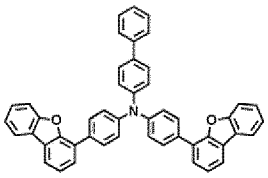
HT19



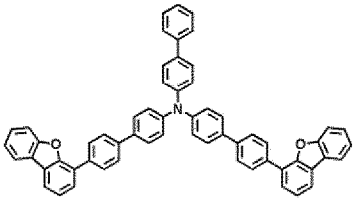
HT20



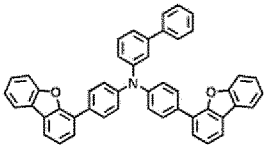
HT21



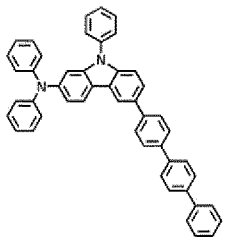
HT22



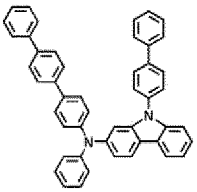
HT23



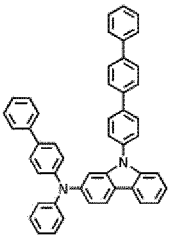
HT24



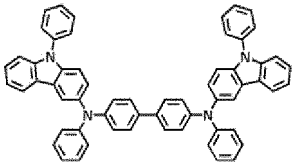
HT25



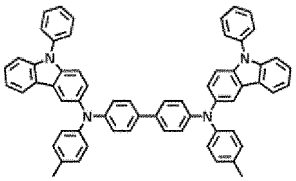
HT26



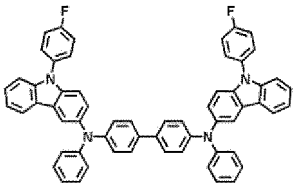
HT27



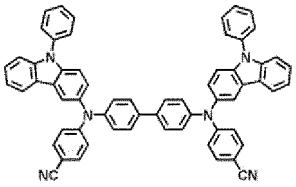
HT28



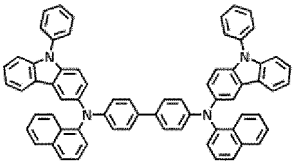
HT29



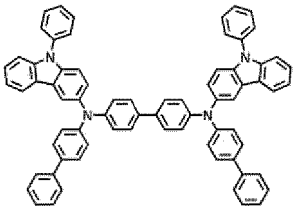
HT30



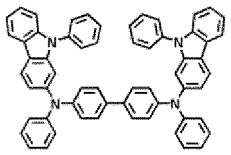
HT31



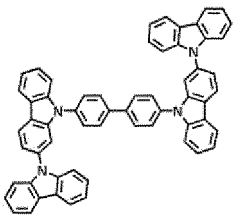
HT32



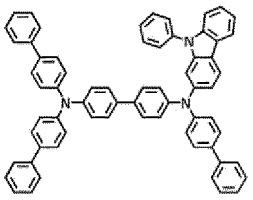
HT33



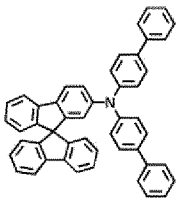
HT34



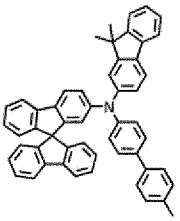
HT35



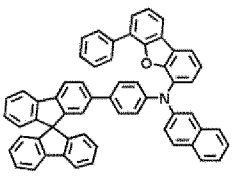
HT36



HT37



HT38



HT39

[0123] A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, for example, about

100 Å to about 7000 Å, about 100 Å to about 5000 Å, about 100 Å to about 3000 Å, or about 100 Å to about 1,000 Å. When the hole transport region includes at least one of a hole injection layer and a hole transport layer, a thickness of the hole injection layer may be in a range of about 100 Å to about 9,000 Å, for example, about 100 Å to about 7,000 Å, about 100 Å to about 5,000 Å, about 100 Å to about 3,000 Å, about 100 Å to about 2,000 Å or about 100 Å to about 1,000 Å, and a thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, for example about 100 Å to about 1,500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within these ranges, satisfactory hole transporting characteristics may be obtained without a substantial increase in driving voltage.

[0124] The emission auxiliary layer may increase light-emission efficiency by compensating for an optical resonance distance according to the wavelength of light emitted by an emission layer, and the electron blocking layer may block the flow of electrons from an electron transport region. The emission auxiliary layer and the electron blocking layer may include the materials as described above.

p-dopant

[0125] The hole transport region may further include, in addition to these materials, a charge-generation material for the improvement of conductive properties. The charge-generation material may be homogeneously or non-homogeneously dispersed in the hole transport region.

[0126] The charge-generation material may be, for example, a p-dopant.

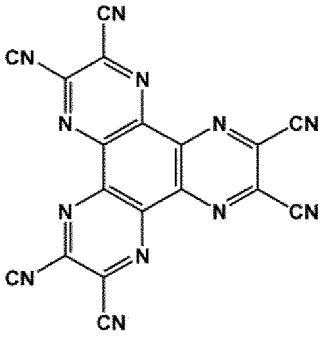
[0127] In one embodiment, the p-dopant may have a lowest unoccupied molecular orbital (LUMO) level of -3.5 eV or less.

[0128] The p-dopant may include at least one selected from a quinone derivative, a metal oxide, and a cyano group-containing compound, but embodiments of the present disclosure are not limited thereto.

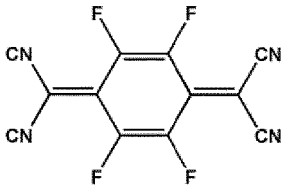
[0129] For example, the p-dopant may include at least one selected from:

a quinone derivative, such as tetracyanoquinodimethane (TCNQ) and 2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane (F4-TCNQ);
a metal oxide, such as tungsten oxide and molybdenum oxide;
1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (HAT-CN); and
a compound represented by Formula 221,
but embodiments of the present disclosure are not limited thereto:

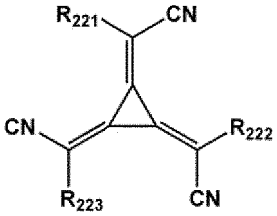
HAT-CN



F4-TCNQ



Formula 221



[0130] In Formula 221,

R_{221} to R_{223} may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{32}) aryl

group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, wherein at least one selected from R_{221} to R_{223} may have at least one substituent selected from a cyano group, -F, -Cl, -Br, -I, a C_1-C_{20} alkyl group substituted with -F, a C_1-C_{20} alkyl group substituted with -Cl, a C_1-C_{20} alkyl group substituted with -Br, and a C_1-C_{20} alkyl group substituted with -I.

Emission layer in organic layer 150

[0131] When the organic light-emitting device 10 is a full-color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, or a blue emission layer, according to a sub-pixel. In one or more embodiments, the emission layer may have a stacked structure of two or more layers selected from a red emission layer, a green emission layer, and a blue emission layer, in which the two or more layers contact each other or are separated from each other. In one or more embodiments, the emission layer may include two or more materials selected from a red light-emitting material, a green light-emitting material, and a blue light-emitting material, in which the two or more materials are mixed with each other in a single layer to emit white light.

[0132] The emission layer comprises a host and a dopant, the host comprises a first compound represented by Formula 1 and the dopant comprises a second compound represented by Formula 2A or 2B.

[0133] The dopant may include at least one selected from a phosphorescent dopant and a fluorescent dopant.

[0134] For example, the dopant may include a phosphorescent dopant, and the phosphorescent dopant may include the second compound.

[0135] An amount of the dopant in the emission layer may be in a range of about 0.01 parts by weight to about 15 parts by weight based on 100 parts by weight of the host, but embodiments of the present disclosure are not limited thereto.

[0136] A thickness of the emission layer may be in a range of about 100 Å to about 1,000 Å, for example, about 100 Å to about 800 Å, about 150 Å to about 800 Å, about 150 Å to about 700 Å, about 150 Å to about 650 Å, about 200 Å to about 600 Å or about 200 Å to about 400 Å. When the thickness of the emission layer is within this range, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

Host in emission layer

[0137] In one or more embodiments, the host may further include, in addition to the first compound, a compound represented by Formula 301:

Formula 301 $$[Ar_{301}]_{xb11}\text{-}[(L_{301})_{xb1}\text{-}R_{301}]_{xb21},$$

[0138] In Formula 301,

Ar_{301} may be a substituted or unsubstituted C_5-C_{60} carbocyclic group or a substituted or unsubstituted C_1-C_{60} heterocyclic group,

xb11 may be 1, 2, or 3,

L_{301} may be selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-C_{60} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

xb1 may be an integer from 0 to 5,

R_{301} may be selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{60} alkyl group, a substituted or unsubstituted C_2-C_{60} alkenyl group, a substituted or unsubstituted C_2-C_{60} alkynyl group, a substituted or unsubstituted C_1-C_{60} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, - $Si(Q_{301})(Q_{302})(Q_{303})$, -$N(Q_{301})(Q_{302})$, -$B(Q_{301})(Q_{302})$, -$C(=O)(Q_{301})$, -$S(=O)_2(Q_{301})$, and - $P(=O)(Q_{301})(Q_{302})$,

xb21 may be an integer from 1 to 5, and

Q_{301} to Q_{303} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a

biphenyl group, a terphenyl group, and a naphthyl group, but embodiments of the present disclosure are not limited thereto.

[0139] For example, Ar_{301} may be a substituted or unsubstituted C_6-C_{32} carbocyclic group or a substituted or unsubstituted C_1-C_{12} heterocyclic group, but embodiments are not limited thereto.

[0140] In one embodiment, Ar_{301} in Formula 301 may be selected from:

a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, and a dibenzothiophene group; and

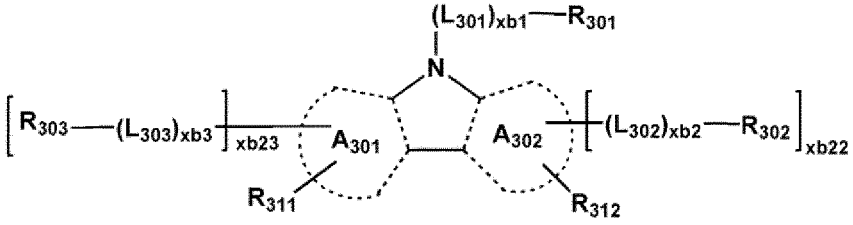
a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, and a dibenzothiophene group, each substituted with at least one selected from deuterium, - F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, - $Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O_2(Q_{31})$, and $-P(=O)(Q_{31})(Q_{32})$, and

Q_{31} to Q_{33} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, but embodiments of the present disclosure are not limited thereto.

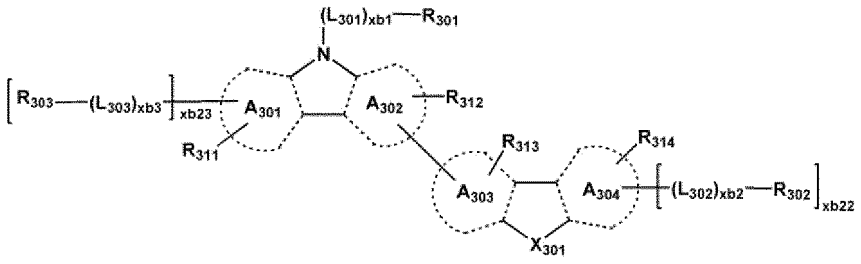
[0141] When xb11 in Formula 301 is two or more, two or more Ar_{301}(s) may be linked via a single bond.

[0142] In one or more embodiments, the compound represented by Formula 301 may be represented by Formula 301-1 or 301-2:

Formula 301-1



Formula 301-2



wherein in Formulae 301-1 and 301-2,

A_{301} to A_{304} may each independently be selected from benzene, a naphthalene, a phenanthrene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a pyridine, a pyrimidine, an indene, a fluorene, a spiro-bifluorene, a benzofluorene, a dibenzofluorene, an indole, a carbazole, benzocarbazole, dibenzocarbazole, a furan, a benzofuran, a dibenzofuran, a naphthofuran, a benzonaphthofuran, dinaphthofuran, a thiophene, a benzothiophene, a dibenzothiophene, a naphthothiophene, a benzonaphthothiophene group, and a dinaphthothiophene group,

X_{301} may be O, S, or N-[$(L_{304})_{xb4}$-R_{304}],

R_{311} to R_{314} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy

group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group $-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$, and $-P(=O)(Q_{31})(Q_{32})$,
xb22 and xb23 may each independently be 0, 1, or 2,
L_{301}, xb1, R_{301}, and Q_{31} to Q_{33} may respectively be defined the same as described above in connection with Formula 301,
L_{302} to L_{304} may each independently be defined the same as described in connection with L_{301},
xb2 to xb4 may each independently be defined the same as described in connection with xb1,
R_{302} to R_{304} may each independently be defined the same as described in connection with R_{301}.

[0143] For example, L_{301} to L_{304} in Formulae 301, 301-1, and 301-2 may each independently be selected from: a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{30} arylene group, a substituted or unsubstituted C_1-C_{20} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group, but embodiments are not limited thereto.

[0144] For example, in Formulae 301, 301-1, and 301-2, L_{301} to L_{304} may each independently be selected form:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, a pyridinylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylene group, an oxadiazolylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group; and
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, a pyridinylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylene group, an oxadiazolylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl

group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an azacarbazolyl group, -Si(Q_{31})(Q_{32})(Q_{33}), -N(Q_{31})(Q_{32}), - B(Q_{31})(Q_{32}), -C(=O)(Q_{31}), -S(=O)$_2$(Q_{31}), and -P(=O)(Q_{31})(Q_{32}), and
Q_{31} to Q_{33} may respectively be defined the same as described above in connection with Formula 301.

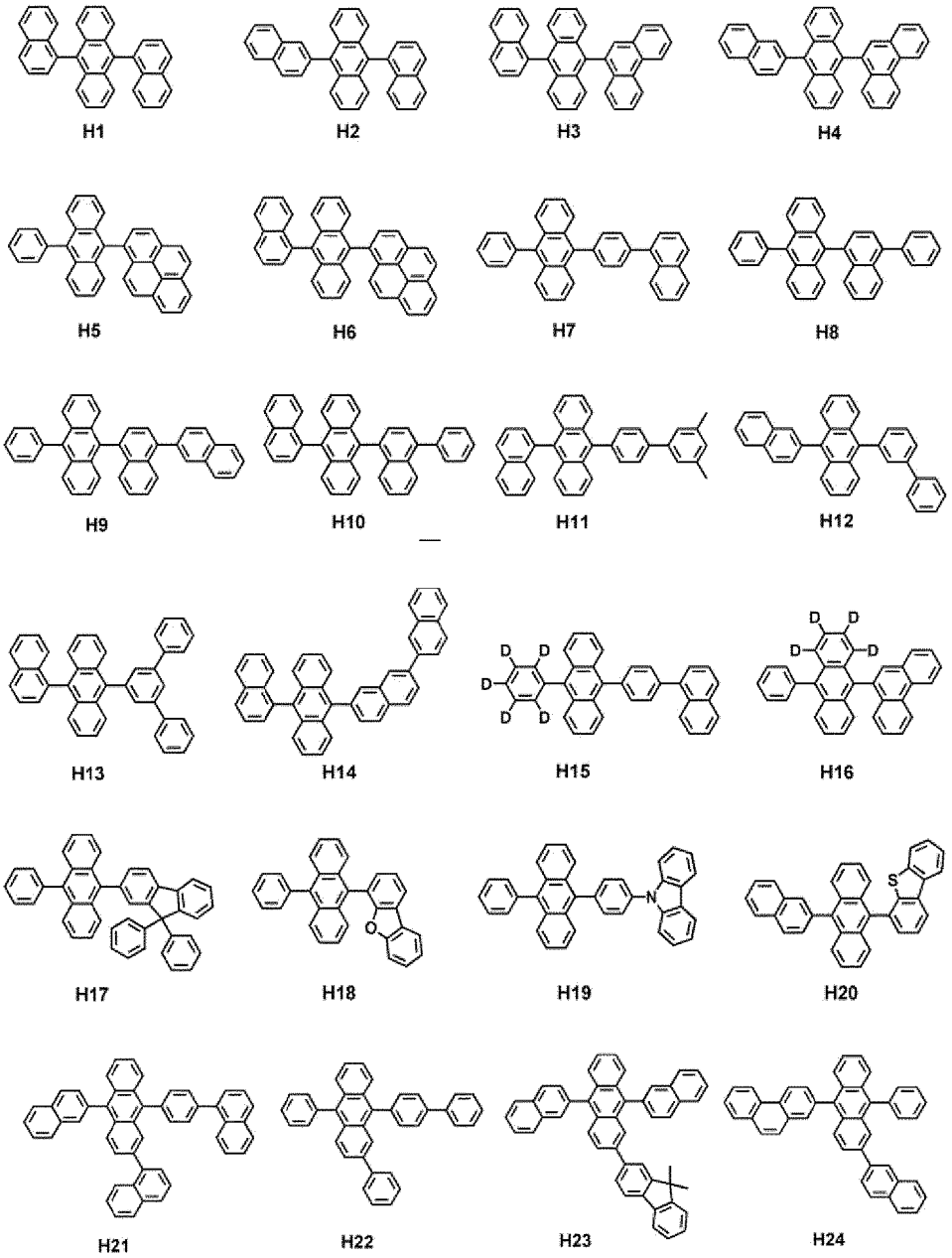
[0145] As another example, R_{301} to R_{304} in Formulae 301, 301-1, and 301-2 may each independently be selected from: deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{10}) alkyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{10}) alkenyl group, a substituted or unsubstituted C_2-C_{60} (*e.g.* C_2-C_{10}) alkynyl group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{10}) alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{30} aryl group, a substituted or unsubstituted C_6-C_{30} aryloxy group, a substituted or unsubstituted C_6-C_{30} arylthio group, a substituted or unsubstituted C_1-C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{301})(Q_{302})(Q_{303}), -N(Q_{301})(Q_{302}), - B(Q_{301})(Q_{302}), -C(=O)(Q_{301}), -S(=O)$_2$(Q_{301}), and -P(=O)(Q_{301})(Q_{302}), but embodiments are not limited thereto.

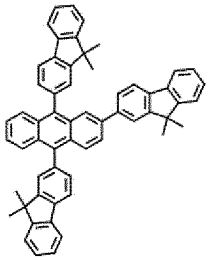
[0146] In one embodiment, in Formulae 301, 301-1, and 301-2, R_{301} to R_{304} may each independently be selected from:

a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group; and
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, an azacarbazolyl group, -Si(Q_{31})(Q_{32})(Q_{33}), -N(Q_{31})(Q_{32}), - B(Q_{31})(Q_{32}), -C(=O)(Q_{31}), -S(=O)$_2$(Q_{31}), and -P(=O)(Q_{31})(Q_{32}), and
Q_{31} to Q_{33} may respectively be defined the same as described above in connection with Formula 301.

[0147] In one or more embodiments, the host may include an alkaline earth metal complex. For example, the host may include a complex selected from a Be complex (for example, Compound H55), a Mg complex, and a Zn complex. For example, the host may be selected from a Be complex (for example, Compound H55), a Mg complex, and a Zn complex.

[0148] The host may include at least one selected from 9,10-di(2-naphthyl)anthracene (ADN), 2-methyl-9,10-bis(naphthalen-2-yl)anthracene (MADN), 9,10-di-(2-naphthyl)-2-t-butyl-anthracene (TBADN), 4,4'-bis(N-carbazolyl)-1,1'-biphenyl (CBP), 1,3,5-tri(carbazol-9-yl)benzene (TCP), and Compounds H1 to H55, but embodiments of the present disclosure are not limited thereto:





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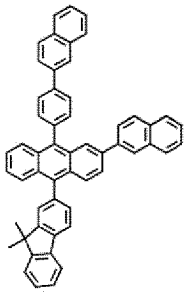

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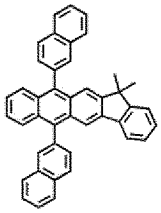

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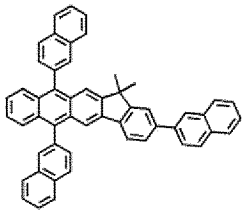

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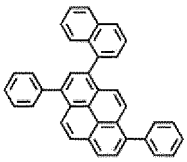

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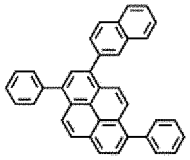

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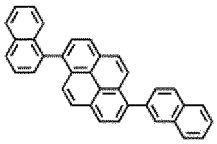

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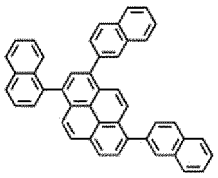

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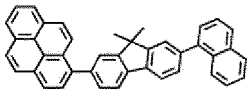

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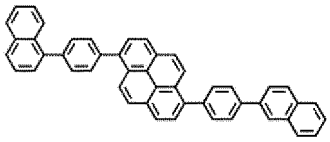
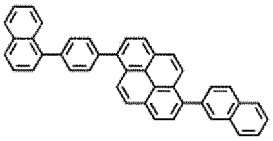


H34



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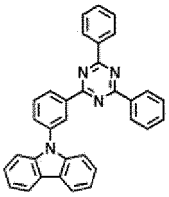

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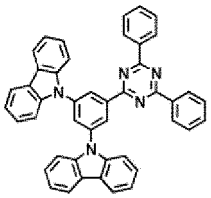

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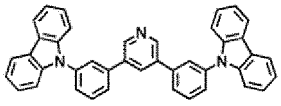

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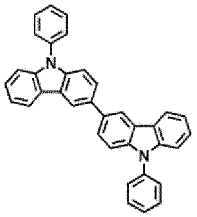

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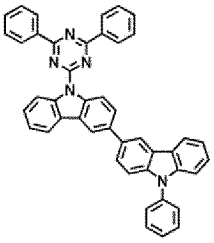

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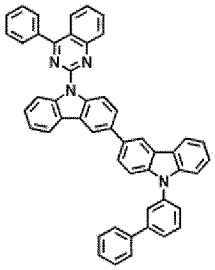

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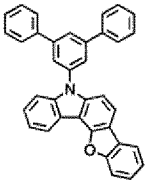

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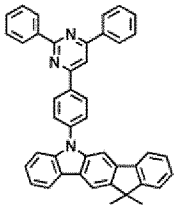

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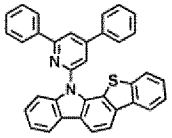

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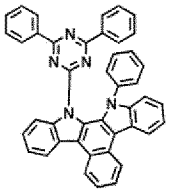

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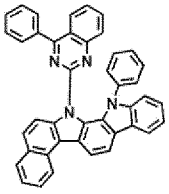

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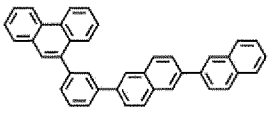

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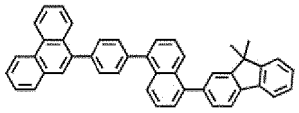

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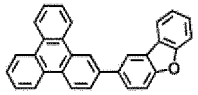

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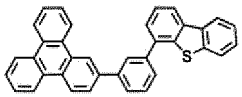
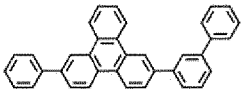
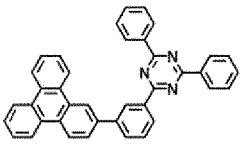


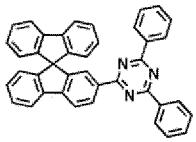
H50



H51



H52



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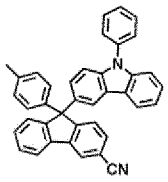
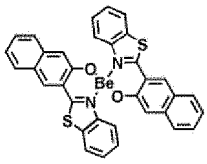


H54



H55

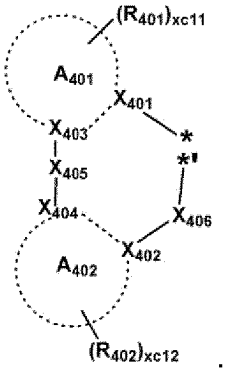
Phosphorescent dopant included in emission layer in organic layer 150

[0149] The phosphorescent dopant may include the second compound.

[0150] The phosphorescent dopant may include an organometallic complex represented by Formula 401 below:

Formula 401 $M(L_{401})x_{c1}(L_{402})_{xc2}$

Formula 402



[0151] In Formulae 401 and 402,

M may be selected from iridium (Ir), platinum (Pt), palladium (Pd), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), rhodium (Rh), and thulium (Tm),

L_{401} may be selected from ligands represented by Formula 402, and xc1 may be 1, 2, or 3, wherein, when xc1 is two or more, two or more L_{401}(s) may be identical to or different from each other,

L_{402} may be an organic ligand, and xc2 may be an integer from 0 to 4, wherein, when xc2 is two or more, two or more L_{402}(s) may be identical to or different from each other,

X_{401} to X_{404} may each independently be nitrogen or carbon;

X_{401} and X_{403} may be linked via a single bond or a double bond, and X_{402} and X_{404} may be linked via a single bond or a double bond,

A_{401} and A_{402} may each independently be a C_5-C_{60} (*e.g.* C_5-C_{30}) carbocyclic group or a C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group,

X_{405} may be a single bond, *-O-*', *-S-*', *-C(=O)-*', *-N(Q_{411})-*', *-C(Q_{411})(Q_{412})-*', *-C(Q_{411})=C(Q_{412})-*', *-C(Q_{411})=*', or *=C(Q_{411})=*', wherein Q_{411} and Q_{412} may be hydrogen, deuterium, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, or a naphthyl group,

X_{406} may be a single bond, O, or S,

R_{401} and R_{402} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{20} alkyl group, a substituted or unsubstituted C_1-C_{20} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{401})(Q_{402})(Q_{403}), -N(Q_{401})(Q_{402}), -B(Q_{401})(Q_{402}), -C(=O)(Q_{401}), -S(=O)$_2$(Q_{401}), and -P(=O)(Q_{401})(Q_{402}), wherein Q_{401} to Q_{403} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a C_6-C_{20} aryl group, and a C_1-C_{20} heteroaryl group,

xc11 and xc12 may each independently be an integer from 0 to 10, and

* and *' in Formula 402 each indicate a binding site to M of Formula 401.

[0152] In one embodiment, in Formula 402, A_{401} and A_{402} may each independently be selected from a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, an indene group, a pyrrole group, a thiophene group, a furan group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a quinoxaline group, a quinazoline group, a carbazole group, a benzimidazole group, a benzofuran group, a benzothiophene group, an isobenzothiophene group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a dibenzofuran group, and a dibenzothiophene group.

[0153] In one or more embodiments, in Formula 402, i) X_{401} may be nitrogen, and X_{402} may be carbon, or ii) X_{401} and X_{402} may each be nitrogen at the same time.

[0154] In one or more embodiments, in Formula 402, R_{401} and R_{402} may each independently be selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, and a C_1-C_{20} alkoxy group;

a C_1-C_{20} alkyl group and a C_1-C_{20} alkoxy group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a phenyl group, a naphthyl group, a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, and a norbornenyl group;

a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, an adamantanyl group, a norbornanyl group, a norbornenyl group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a dibenzofuranyl group, and a dibenzothiophenyl group; and

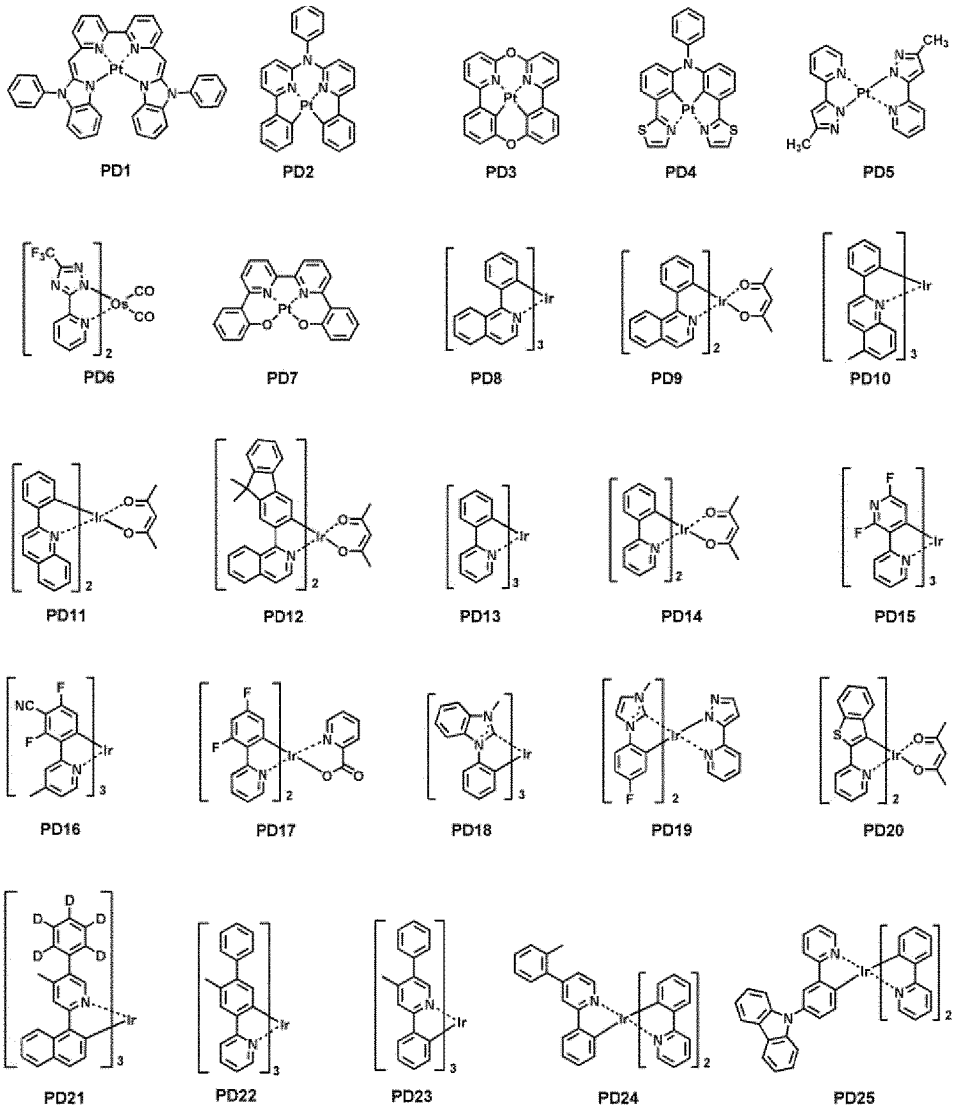
-Si(Q_{401})(Q_{402})(Q_{403}), -N(Q_{401})(Q_{402}), -B(Q_{401})(Q_{402}), -C(=O)(Q_{401}), - S(=O)$_2$(Q_{401}), and -P(=O)(Q_{401})(Q_{402}), and Q_{401} to Q_{403} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, and a naphthyl group, but embodiments of the present disclosure are not limited thereto.

[0155] In one or more embodiments, in Formula 401, when xc1 is two or more, two A_{401}(s) among a plurality of L_{401}(s) may optionally be linked via a linking group, X_{407}, or two A_{402}(s) may optionally be linked via a linking group, X_{408} (see Compounds PD1 to PD4 and PD7). X_{407} and X_{408} may each independently be a single bond, *-O-*', *-S-*', *-C(=O)-*',

-N(Q_{413})-', *-C(Q_{413})(Q_{414})-*', or *-C(Q_{413})=C(Q_{414})-*' (wherein Q_{413} and Q_{414} may each independently be hydrogen, deuterium, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group or a naphthyl group), but embodiments of the present disclosure are not limited thereto.

[0156] L_{402} in Formula 401 may be a monovalent, divalent, or trivalent organic ligand. For example, L_{402} may be selected from halogen, diketone (for example, acetylacetonate), carboxylic acid (for example, picolinate), -C(=O), isonitrile, -CN, and phosphorus (for example, phosphine, or phosphite), but embodiments of the present disclosure are not limited thereto.

[0157] In one or more embodiments, the phosphorescent dopant may be selected from, for example, Compounds PD1 to PD25, but embodiments of the present disclosure are not limited thereto:

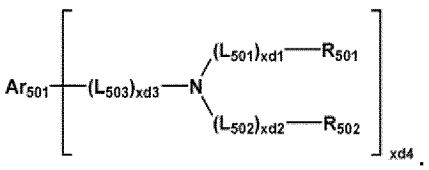


Fluorescent dopant in emission layer

[0158] The fluorescent dopant may include an arylamine compound and/or a styrylamine compound.

[0159] The fluorescent dopant may include a compound represented by Formula 501:

Formula 501



[0160] In Formula 501,

Ar_{501} may be a substituted or unsubstituted C_5-C_{60} carbocyclic group or a substituted or unsubstituted C_1-C_{60} heterocyclic group,
L_{501} to L_{503} may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylene group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,
xd1 to xd3 may each independently be an integer from 0 to 3;
R_{501} and R_{502} may each independently be selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a substituted or unsubstituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a substituted or unsubstituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, and
xd4 may be an integer from 1 to 6.

[0161] For example, Ar_{501} may be a substituted or unsubstituted C_5-C_{30} carbocyclic group or a substituted or unsubstituted C_1-C_{20} heterocyclic group, but embodiments are not limited thereto.

[0162] In one embodiment, Ar_{501} in Formula 501 may be selected from:

a naphthalene group, a heptalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, and an indenophenanthrene group; and
a naphthalene group, a heptalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, and an indenophenanthrene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0163] In one or more embodiments, L_{501} to L_{503} in Formula 501 may each independently be selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, and a pyridinylene group; and
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, and a pyridinylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group,

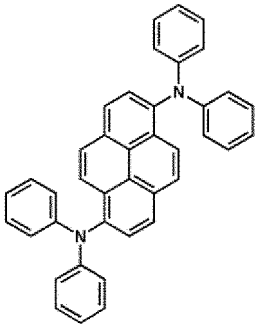
a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group.

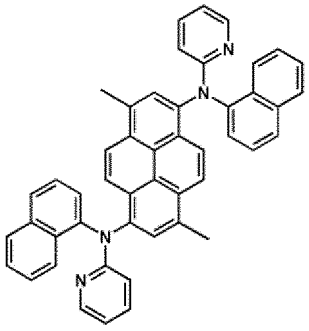
[0164] In one or more embodiments, in Formula 501, R_{501} and R_{502} may each independently be selected from:

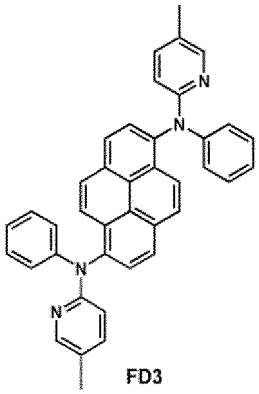
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, and a pyridinyl group; and
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, and - $Si(Q_{31})(Q_{32})(Q_{33})$, and
Q_{31} to Q_{33} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

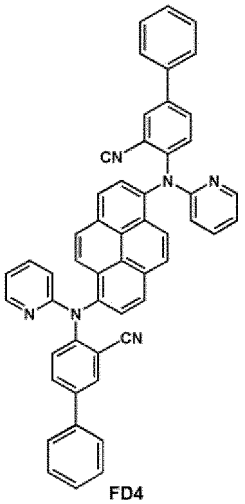
[0165] In one or more embodiments, xd4 in Formula 501 may be 2, but embodiments of the present disclosure are not limited thereto.

[0166] For example, the fluorescent dopant may be selected from Compounds FD1 to FD22:

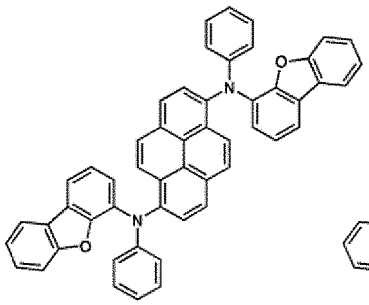

FD1


FD2

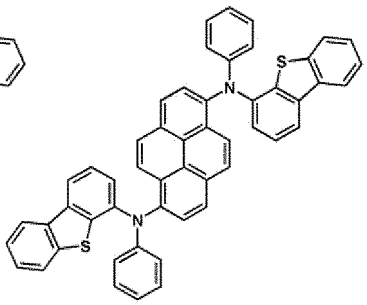

FD3



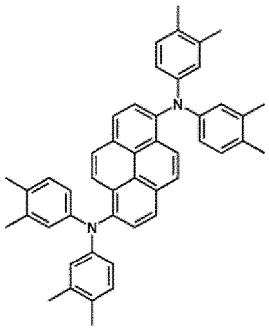
FD4



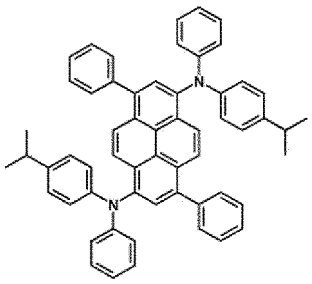
FD5



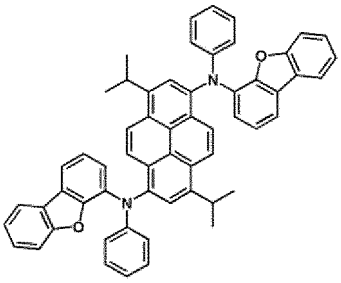
FD6



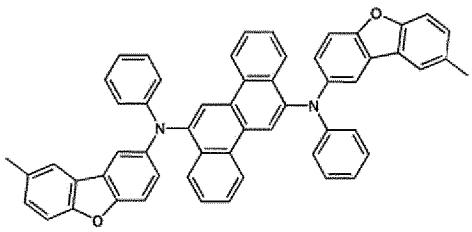
FD7



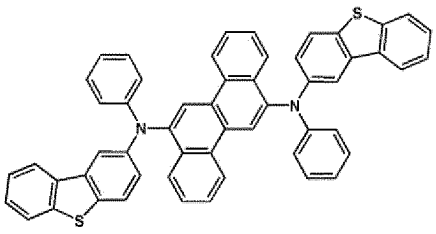
FD8



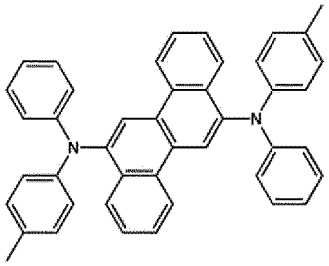
FD9



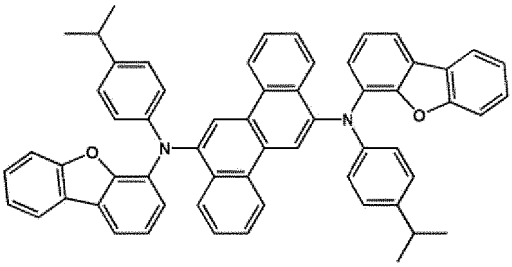
FD10



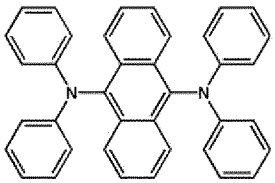
FD11



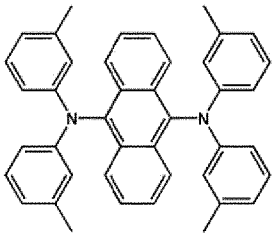
FD12



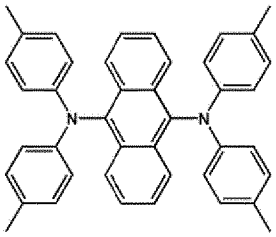
FD13



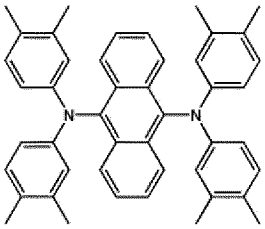
FD14



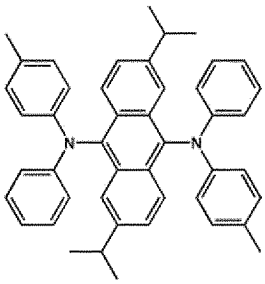
FD15



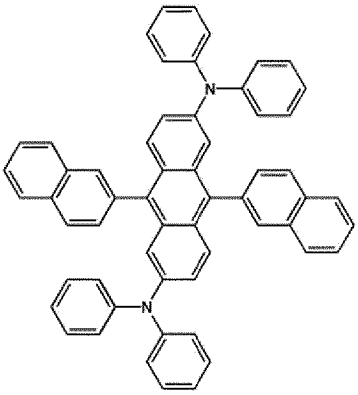
FD16



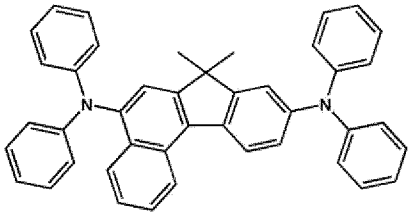
FD17



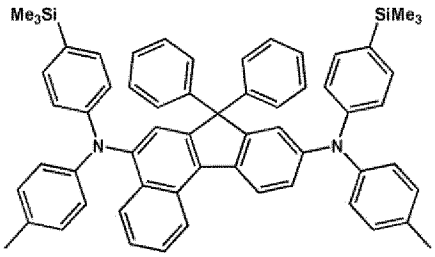
FD18



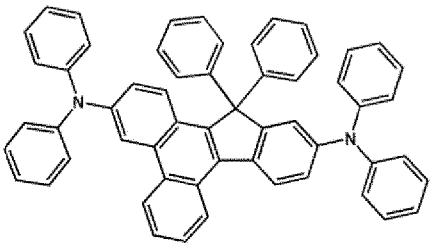
FD19



FD20

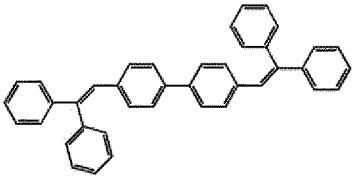


FD21

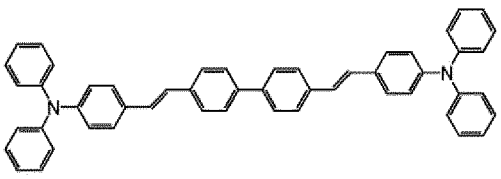


FD22

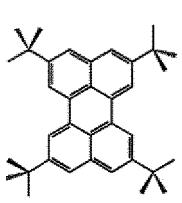
[0167] In one or more embodiments, the fluorescent dopant may be selected from the following compounds, but embodiments of the present disclosure are not limited thereto.



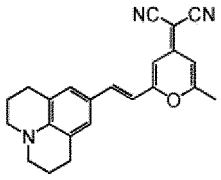
DPVBi



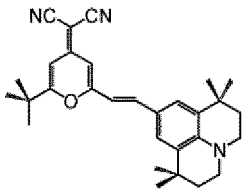
DPAVBi



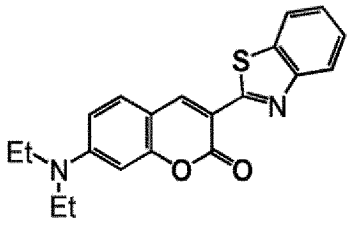
TBPe



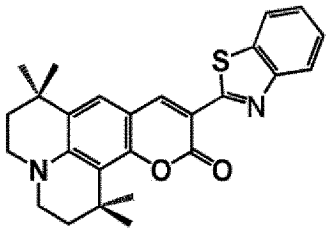
DCM



DCJTB



Coumarin 6



C545T

Electron transport region in organic layer 150

[0168] The electron transport region may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

[0169] The electron transport region may include at least one selected from a buffer layer, a hole blocking layer, an electron control layer, an electron transport layer, and an electron injection layer, but embodiments of the present disclosure are not limited thereto.

[0170] For example, the electron transport region may have an electron transport layer/electron injection layer structure, a hole blocking layer/electron transport layer/electron injection layer structure, an electron control layer/electron transport layer/electron injection layer structure, or a buffer layer/electron transport layer/electron injection layer structure, wherein for each structure, constituting layers are sequentially stacked from an emission layer. However, embodiments of the structure of the electron transport region are not limited thereto.

[0171] The electron transport region (for example, a buffer layer, a hole blocking layer, an electron control layer, or an electron transport layer in the electron transport region) may include a metal-free compound containing at least one π electron-depleted nitrogen-containing ring.

[0172] The term "π electron-depleted nitrogen-containing ring" refers to a C_1-C_{60} (*e.g.* a C_1-C_{30}) heterocyclic group having at least one *-N=*' moiety as a ring-forming moiety.

[0173] For example, the "π electron-depleted nitrogen-containing ring" may be i) a 5-membered to 7-membered heteromonocyclic group having at least one *-N=*' moiety, ii) a heteropolycyclic group in which two or more 5-membered to 7-membered heteromonocyclic groups each having at least one *-N=*' moiety are condensed with each other, or iii) a heteropolycyclic group in which at least one of 5-membered to 7-membered heteromonocyclic groups, each having at least one *-N=*' moiety, is condensed with at least one C_5-C_{60} (*e.g.* a C_5-C_{30}) carbocyclic group.

[0174] Examples of the π electron-depleted nitrogen-containing ring include an imidazole, a pyrazole, a thiazole, an isothiazole, an oxazole, an isoxazole, a pyridine, a pyrazine, a pyrimidine, a pyridazine, an indazole, a purine, a quinoline, an isoquinoline, a benzoquinoline, a phthalazine, a naphthyridine, a quinoxaline, a quinazoline, a cinnoline, a phenanthridine, an acridine, a phenanthroline, a phenazine, a benzimidazole, an isobenzothiazole, a benzoxazole, an isobenzoxazole, a triazole, a tetrazole, an oxadiazole, a triazine, thiadiazole, an imidazopyridine, an imidazopyrimidine, and an azacarbazole, but embodiments of the present disclosure are not limited thereto.

[0175] For example, the electron transport region may include a compound represented by Formula 601:

Formula 601 $$[Ar_{601}]_{xe11}\text{-}[(L_{601})_{xe1}\text{-}R_{601}]_{xe21}.$$

[0176] In Formula 601,

Ar_{601} may be a substituted or unsubstituted C_5-C_{60} carbocyclic group or a substituted or unsubstituted C_1-C_{60} heterocyclic group,

xe11 may be 1, 2, or 3,

L_{601} may be selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted

C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-C_{60} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

xe1 may be an integer from 0 to 5,

R_{601} may be selected from a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, $-Si(Q_{601})(Q_{602})(Q_{603})$, $-C(=O)(Q_{601})$, $-S(=O)_2(Q_{601})$, and $-P(=O)(Q_{601})(Q_{602})$, and

Q_{601} to Q_{603} may each independently be a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, or a naphthyl group, and

xe21 may be an integer from 1 to 5.

[0177] In one embodiment, at least one of Ar_{601}(s) in the number of xe11 and R_{601}(s) in the number of xe21 may include the π electron-depleted nitrogen-containing ring.

[0178] For example, Ar_{601} may be a substituted or unsubstituted C_5-C_{30} carbocyclic group or a substituted or unsubstituted C_1-C_{20} heterocyclic group, but embodiments are not limited thereto.

[0179] In one embodiment, in Formula 601, ring Ar_{601} may be selected from:

a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group; and

a benzene group, a naphthalene group, a fluorene group, a spiro-bifluorene group, a benzofluorene group, a dibenzofluorene group, a phenalene group, a phenanthrene group, an anthracene group, a fluoranthene group, a triphenylene group, a pyrene group, a chrysene group, a naphthacene group, a picene group, a perylene group, a pentaphene group, an indenoanthracene group, a dibenzofuran group, a dibenzothiophene group, a carbazole group, an imidazole group, a pyrazole group, a thiazole group, an isothiazole group, an oxazole group, an isoxazole group, a pyridine group, a pyrazine group, a pyrimidine group, a pyridazine group, an indazole group, a purine group, a quinoline group, an isoquinoline group, a benzoquinoline group, a phthalazine group, a naphthyridine group, a quinoxaline group, a quinazoline group, a cinnoline group, a phenanthridine group, an acridine group, a phenanthroline group, a phenazine group, a benzimidazole group, an isobenzothiazole group, a benzoxazole group, an isobenzoxazole group, a triazole group, a tetrazole group, an oxadiazole group, a triazine group, a thiadiazole group, an imidazopyridine group, an imidazopyrimidine group, and an azacarbazole group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, $-Si(Q_{31})(Q_{32})(Q_{33})$, $-S(=O)_2(Q_{31})$, and $-P(=O)(Q_{31})(Q_{32})$, and

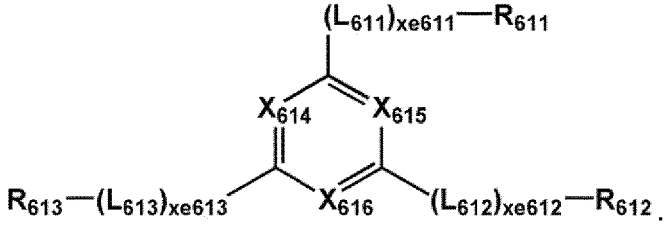
Q_{31} to Q_{33} may each independently be selected from a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0180] When xe11 in Formula 601 is two or more, two or more Ar_{601}(s) may be linked via a single bond.

[0181] In one or more embodiments, Ar_{601} in Formula 601 may be an anthracene group.

[0182] In one or more embodiments, the compound represented by 601 may be represented by Formula 601-1:

Formula 601-1



[0183] In Formula 601-1,

X_{614} may be N or C(R_{614}), X_{615} may be N or C(R_{615}), and X_{616} may be N or C(R_{616}), wherein at least one selected from X_{614} to X_{616} may be N,
L_{611} to L_{613} may each independently be defined the same as described in connection with L_{601},
xe611 to xe613 may each independently be defined the same as described in connection with xe1,
R_{611} to R_{613} may each independently be defined the same as described in connection with R_{601}, and
R_{614} to R_{616} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

[0184] For example, L_{601} and L_{611} to L_{613} in Formulae 601 and 601-1 may each independently be selected from: a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{30} arylene group, a substituted or unsubstituted C_1-C_{20} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group, but embodiments are not limited thereto.

[0185] In one embodiment, L_{601} and L_{611} to L_{613} in Formulae 601 and 601-1 may each independently be selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, a pyridinylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylene group, an oxadiazolylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group; and
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-bifluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a thiophenylene group, a furanylene group, a carbazolylene group, an indolylene group, an isoindolylene group, a benzofuranylene group, a benzothiophenylene group, a dibenzofuranylene group, a dibenzothiophenylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a dibenzosilolylene group, a pyridinylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a thiadiazolylene group, an oxadiazolylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a triazinylene group, a quinolinylene group, an isoquinolinylene group, a benzoquinolinylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylene group, a quinazolinylene group, a cinnolinylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzimidazolylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isobenzoxazolylene group, a triazolylene group, a tetrazolylene group, an imidazopyridinylene group, an imidazopyrimidinylene group, and an azacarbazolylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a

hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;
but embodiments of the present disclosure are not limited thereto.

[0186] In one or more embodiments, xe1 and xe611 to xe613 in Formulae 601 and 601-1 may each independently be 0, 1, or 2.

[0187] For example, R_{601} and R_{611} to R_{613} in Formulae 601 and 601-1 may each independently be selected from: a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{30} aryl group, a substituted or unsubstituted C_6-C_{30} aryloxy group, a substituted or unsubstituted C_6-C_{30} arylthio group, a substituted or unsubstituted C_1-C_{20} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, - $Si(Q_{601})(Q_{602})(Q_{603})$, $-C(=O)(Q_{601})$, $-S(=O)_2(Q_{601})$, and $-P(=O)(Q_{601})(Q_{602})$.

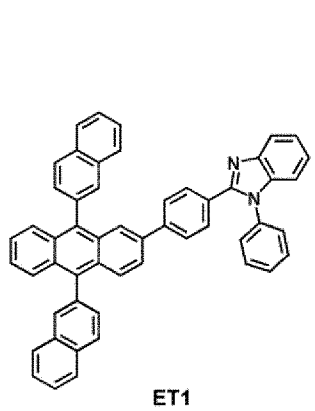
[0188] In one or more embodiments, in Formulae 601 and 601-1, R_{601} and R_{611} to R_{613} may each independently be selected from:

a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group;
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-bifluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a thiophenyl group, a furanyl group, a carbazolyl group, an indolyl group, an isoindolyl group, a benzofuranyl group, a benzothiophenyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a

dibenzocarbazolyl group, a dibenzosilolyl group, a pyridinyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a thiadiazolyl group, an oxadiazolyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzimidazolyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and an azacarbazolyl group; and $-S(=O)_2(Q_{601})$ and $-P(=O)(Q_{601})(Q_{602})$, and

Q_{601} and Q_{602} may respectively be defined the same as described above.

[0189] The electron transport region may include at least one compound selected from Compounds ET1 to ET36, but embodiments of the present disclosure are not limited thereto:



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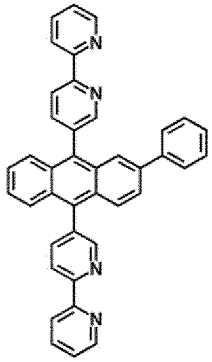

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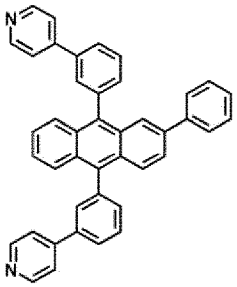

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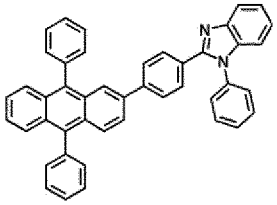
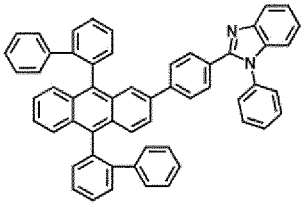


ET4



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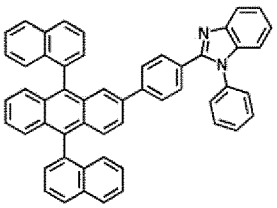

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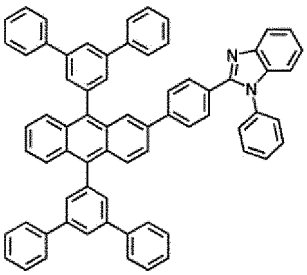

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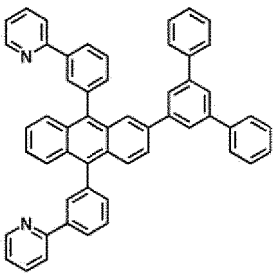

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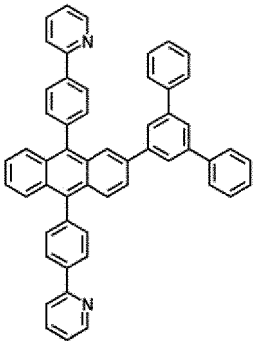

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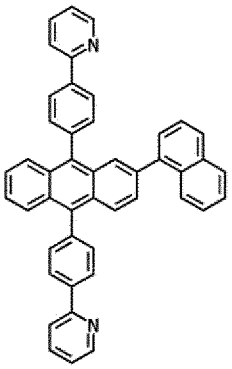

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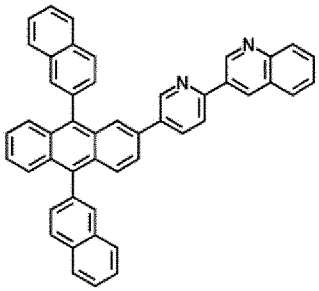

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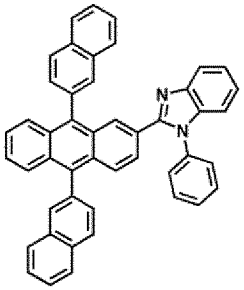

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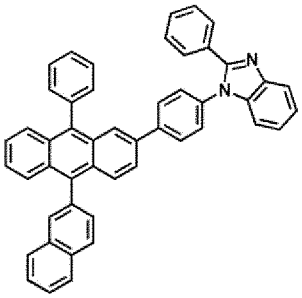

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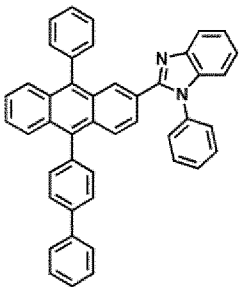

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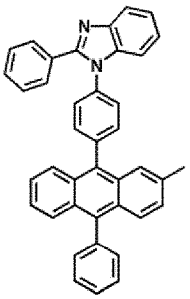

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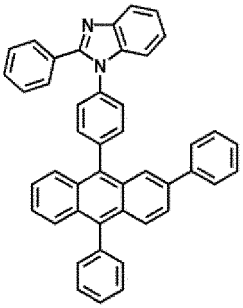

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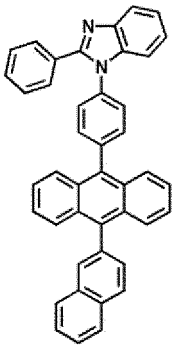

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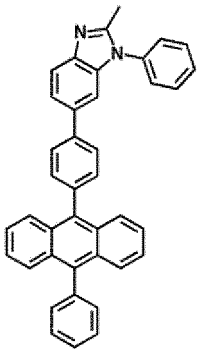

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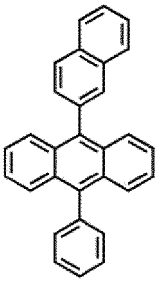

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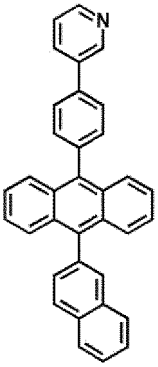

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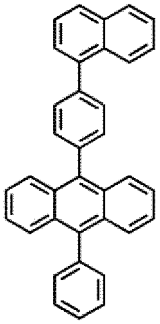

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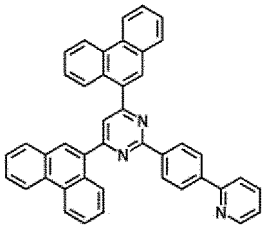

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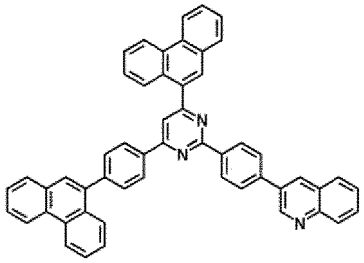

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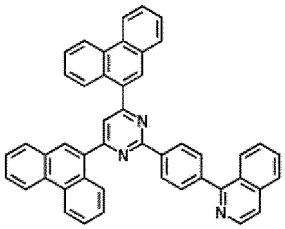

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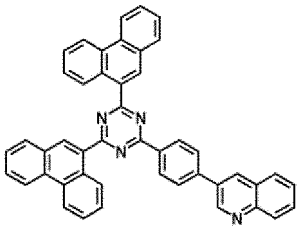

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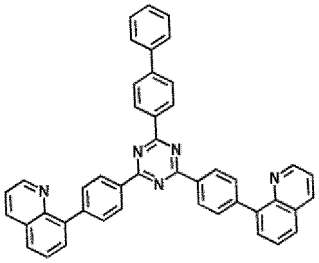

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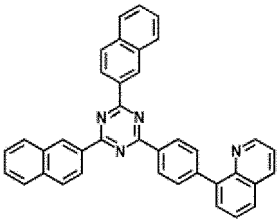

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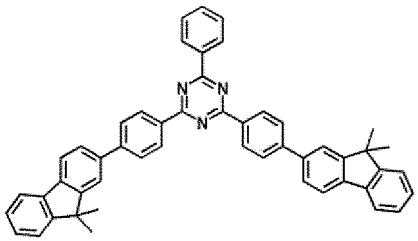

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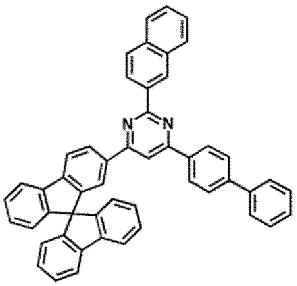

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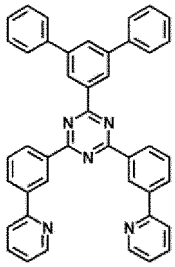

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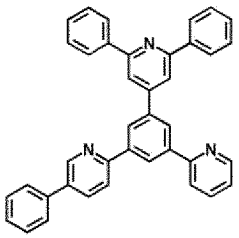

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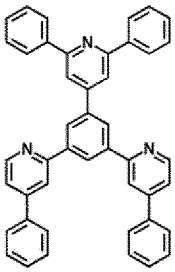

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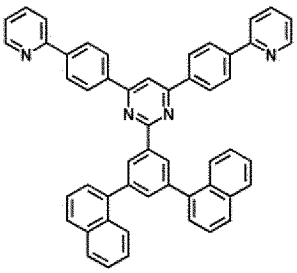

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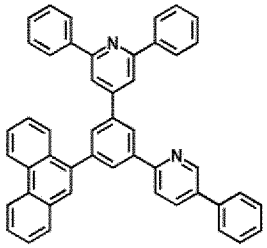
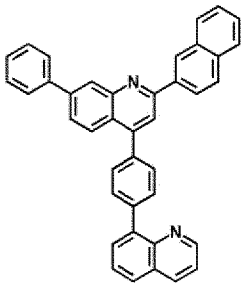
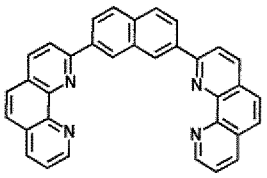


ET34



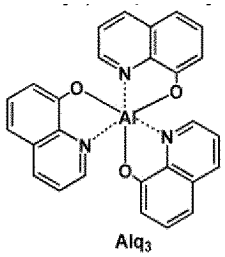
ET35

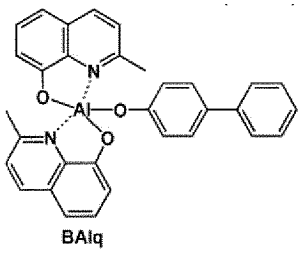


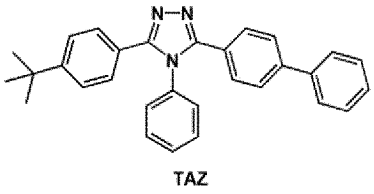
ET36

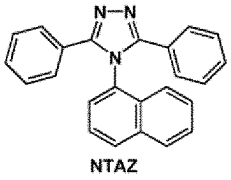
[0190] In one or more embodiments, the electron transport region may include at least one compound selected from 2,9-

dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP), 4,7-diphenyl-1,10-phenanthroline (Bphen), Alq_3, BAlq, 3-(biphenyl-4-yl)-5-(4-tert-butylphenyl)-4-phenyl-4H-1,2,4-triazole (TAZ), and NTAZ.









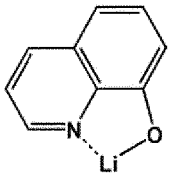
[0191] A thickness of the buffer layer, the hole blocking layer, or the electron control layer may be in a range of about 20 Å to about 1,000 Å, for example, about 20 Å to about 700 Å, about 20 Å to about 500 Å, about 20 Å to about 400 Å, about 30 Å to about 400 Å or about 30 Å to about 300 Å. When the thicknesses of the buffer layer, the hole blocking layer, and the electron control layer are within these ranges, the electron blocking layer may have excellent electron blocking characteristics or electron control characteristics without a substantial increase in driving voltage.

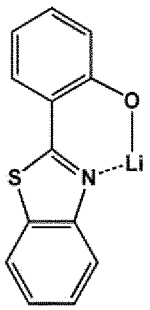
[0192] A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, for example, about 100 Å to about 700 Å, about 100 Å to about 600 Å, about 150 Å to about 600 Å, about 150 Å to about 500 Å or about 250 Å to about 350 Å. When the thickness of the electron transport layer is within the range described above, the electron transport layer may have satisfactory electron transport characteristics without a substantial increase in driving voltage.

[0193] The electron transport region (for example, the electron transport layer in the electron transport region) may further include, in addition to the materials described above, a metal-containing material.

[0194] The metal-containing material may include at least one selected from alkali metal complex and alkaline earth-metal complex. The alkali metal complex may include a metal ion selected from a Li ion, a Na ion, a K ion, a Rb ion, and a Cs ion, and the alkaline earth-metal complex may include a metal ion selected from a Be ion, a Mg ion, a Ca ion, a Sr ion, and a Ba ion. A ligand coordinated with the metal ion of the alkali metal complex or the alkaline earth-metal complex may be selected from a hydroxy quinoline, a hydroxy isoquinoline, a hydroxy benzoquinoline, a hydroxy acridine, a hydroxy phenanthridine, a hydroxy phenyloxazole, a hydroxy phenylthiazole, a hydroxy diphenyloxadiazole, a hydroxy diphenylthiadiazole, a hydroxy phenylpyridine, a hydroxy phenylbenzimidazole, a hydroxy phenylbenzothiazole, a bipyridine, a phenanthroline, and a cyclopentadiene, but embodiments of the present disclosure are not limited thereto.

[0195] For example, the metal-containing material may include a Li complex. The Li complex may include, for example, Compound ET-D1 (lithium quinolate, LiQ) or ET-D2.





[0196] The electron transport region may include an electron injection layer that facilitates injection of electrons from the second electrode 190. The electron injection layer may directly contact the second electrode 190.

[0197] The electron injection layer may have i) a single-layered structure including a single layer including a single material, ii) a single-layered structure including a single layer including a plurality of different materials, or iii) a multi-layered structure having a plurality of layers including a plurality of different materials.

[0198] The electron injection layer may include an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof.

[0199] The alkali metal may be selected from Li, Na, K, Rb, and Cs. In one embodiment, the alkali metal may be Li, Na, or Cs. In one or more embodiments, the alkali metal may be Li or Cs, but embodiments of the present disclosure are not limited thereto.

[0200] The alkaline earth metal may be selected from Mg, Ca, Sr, and Ba.

[0201] The rare earth metal may be selected from Sc, Y, Ce, Tb, Yb, and Gd.

[0202] The alkali metal compound, the alkaline earth-metal compound, and the rare earth metal compound may be selected from oxides and halides (for example, fluorides, chlorides, bromides, or iodides) of the alkali metal, the alkaline earth-metal, and the rare earth metal.

[0203] The alkali metal compound may be selected from alkali metal oxides (such as Li_2O, Cs_2O, or K_2O), and alkali metal halides (such as LiF, NaF, CsF, KF, LiI, NaI, CsI, KI, or RbI). In one embodiment, the alkali metal compound may be selected from LiF, Li_2O, NaF, LiI, NaI, CsI, and KI, but embodiments of the present disclosure are not limited thereto.

[0204] The alkaline earth-metal compound may be selected from alkaline earth-metal compounds, such as BaO, SrO, CaO, $Ba_xSr_{1-x}O$ ($0<x<1$), or $Ba_xCa_{1-x}O$ ($0<x<1$). In one embodiment, the alkaline earth-metal compound may be selected from BaO, SrO, and CaO, but embodiments of the present disclosure are not limited thereto.

[0205] The rare earth metal compound may be selected from YbF_3, ScF_3, ScO_3, Y_2O_3, Ce_2O_3, GdF_3, and TbF_3. In one embodiment, the rare earth metal compound may be selected from YbF_3, ScF_3, TbF_3, YbI_3, ScI_3, and TbI_3, but embodiments of the present disclosure are not limited thereto.

[0206] The alkali metal complex, the alkaline earth-metal complex, and the rare earth metal complex may include an ion of alkali metal, alkaline earth-metal, and rare earth metal as described above, and a ligand coordinated with a metal ion of the alkali metal complex, the alkaline earth-metal complex, or the rare earth metal complex may be selected from hydroxy quinoline, hydroxy isoquinoline, hydroxy benzoquinoline, hydroxy acridine, hydroxy phenanthridine, hydroxy phenyloxazole, hydroxy phenylthiazole, hydroxy diphenyloxadiazole, hydroxy diphenylthiadiazole, hydroxy phenylpyridine, hydroxy phenylbenzimidazole, hydroxy phenylbenzothiazole, bipyridine, phenanthroline, and cyclopentadiene, but embodiments of the present disclosure are not limited thereto.

[0207] The electron injection layer may include (e.g., consist of) an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof, as described above. In one or more embodiments, the electron injection layer may further include an organic material. When the electron injection layer further includes an organic material, an alkali metal, an alkaline earth metal, a rare earth metal, an alkali metal compound, an alkaline earth-metal compound, a rare earth metal compound, an alkali metal complex, an alkaline earth-metal complex, a rare earth metal complex, or any combinations thereof may be homogeneously or non-homogeneously dispersed in a matrix including the organic material.

[0208] A thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, for example, about 3 Å to about 90 Å or about 3 Å to about 20 Å. When the thickness of the electron injection layer is within the range described above, the electron injection layer may have satisfactory electron injection characteristics without a substantial increase in driving voltage.

Second electrode 190

[0209] The second electrode 190 may be disposed on the organic layer 150 having such a structure. The second electrode 190 may be a cathode which is an electron injection electrode, and in this regard, a material for forming the second electrode 190 may be selected from metal, an alloy, an electrically conductive compound, and a combination thereof, which have a relatively low work function.

[0210] The second electrode 190 may include at least one selected from lithium (Li), silver (Ag), magnesium (Mg), aluminium (Al), aluminium-lithium (Al-Li), calcium (Ca), magnesium-indium (Mg-In), magnesium-silver (Mg-Ag), ITO, and IZO, but embodiments of the present disclosure are not limited thereto. The second electrode 190 may be a transmissive electrode, a semi-transmissive electrode, or a reflective electrode.

[0211] The second electrode 190 may have a single-layered structure, or a multi-layered structure including two or more layers.

[0212] Hereinbefore, the organic light-emitting device has been described with reference to the drawing, but embodiments of the present disclosure are not limited thereto.

[0213] Layers constituting the hole transport region, the emission layer, and layers constituting the electron transport region may be formed in a certain region utilizing one or more suitable methods selected from vacuum deposition, spin coating, casting, Langmuir-Blodgett (LB) deposition, ink-jet printing, laser-printing, and laser-induced thermal imaging.

[0214] When layers constituting the hole transport region, the emission layer, and layers constituting the electron

transport region are formed by vacuum deposition, the deposition may be performed at a deposition temperature of about 100 °C to about 500 °C, a vacuum degree of about 10^{-8} torr to about 10^{-3} torr, and a deposition speed of about 0.01 Å/sec to about 100 Å/sec by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

[0215] When layers constituting the hole transport region, the emission layer, and layers constituting the electron transport region are formed by spin coating, the spin coating may be performed at a coating speed of about 2,000 rpm to about 5,000 rpm and at a heat treatment temperature of about 80°C to about 200°C by taking into account a material to be included in a layer to be formed, and the structure of a layer to be formed.

[0216] A flat display apparatus according to another aspect of the present disclosure may include: the organic light-emitting device and a transistor, wherein the transistor includes a source electrode, a drain electrode, a gate electrode, and an activation layer, and the first electrode of the organic light-emitting device is electrically connected to at least one of the source electrode and the drain electrode of the transistor.

[0217] The activation layer of the transistor may be modified to an amorphous silicon layer, a crystalline silicon layer, an organic semiconductive layer, or an oxide semiconductive layer.

[0218] Such a flat display may prevent or reduce red and green emission in a black state, thereby improving brightness-dependent emission efficiency.

General definition of substituents

[0219] The term "C_1-C_{60} alkyl group" as used herein refers to a linear or branched aliphatic saturated hydrocarbon monovalent group having 1 to 60 carbon atoms, and examples thereof include a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an isoamyl group, and a hexyl group. The term "C_1-C_{60} alkylene group" as used herein refers to a divalent group having the same structure as the C_1-C_{60} alkyl group. Corresponding definitions apply to other ranges given for the number of carbon atoms in an alkyl/alkylene group.

[0220] The term "C_2-C_{60} alkenyl group" as used herein refers to a hydrocarbon group having at least one carbon-carbon double bond in the middle or at the terminus of the C_2-C_{60} alkyl group, and examples thereof include an ethenyl group, a propenyl group, and a butenyl group. The term "C_2-C_{60} alkenylene group" as used herein refers to a divalent group having the same structure as the C_2-C_{60} alkenyl group. Corresponding definitions apply to other ranges given for the number of carbon atoms in an alkenyl/alkenylene group.

[0221] The term "C_2-C_{60} alkynyl group" as used herein refers to a hydrocarbon group having at least one carbon-carbon triple bond in the middle or at the terminus of the C_2-C_{60} alkyl group, and examples thereof include an ethynyl group, and a propynyl group. The term "C_2-C_{60} alkynylene group" as used herein refers to a divalent group having the same structure as the C_2-C_{60} alkynyl group. Corresponding definitions apply to other ranges given for the number of carbon atoms in an alkynyl/alkynylene group.

[0222] The term "C_1-C_{60} alkoxy group" as used herein refers to a monovalent group represented by $-OA_{101}$ (wherein A_{101} represents the C_1-C_{60} alkyl group), and examples thereof include a methoxy group, an ethoxy group, and an isopropyloxy group. Corresponding definitions apply to other ranges given for the number of carbon atoms in an alkoxy group.

[0223] The term "C_3-C_{10} cycloalkyl group" as used herein refers to a monovalent saturated hydrocarbon monocyclic group having 3 to 10 carbon atoms, and examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. The term "C_3-C_{10} cycloalkylene group" as used herein refers to a divalent group having the same structure as the C_3-C_{10} cycloalkyl group.

[0224] The term "C_1-C_{10} heterocycloalkyl group" as used herein refers to a monovalent monocyclic group having at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom in addition to 1 to 10 carbon atoms, and examples thereof include a 1,2,3,4-oxatriazolidinyl group, a tetrahydrofuranyl group, and a tetrahydrothiophenyl group. The term "C_1-C_{10} heterocycloalkylene group" as used herein refers to a divalent group having the same structure as the C_1-C_{10} heterocycloalkyl group.

[0225] The term "C_3-C_{10} cycloalkenyl group" as used herein refers to a monovalent monocyclic group that has 3 to 10 carbon atoms and at least one carbon-carbon double bond in the ring thereof and no aromaticity, and examples thereof include a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. The term "C_3-C_{10} cycloalkenylene group" as used herein refers to a divalent group having the same structure as the C_3-C_{10} cycloalkenyl group.

[0226] The term "C_1-C_{10} heterocycloalkenyl group" as used herein refers to a monovalent monocyclic group that has at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom in addition to 1 to 10 carbon atoms, and at least one carbon-carbon double bond in its ring. Non-limiting examples of the C_1-C_{10} heterocycloalkenyl group include a 4,5-dihydro-1,2,3,4-oxatriazolyl group, a 2,3-dihydrofuranyl group, and a 2,3-dihydrothiophenyl group. The term "C_1-C_{10} heterocycloalkenylene group" as used herein refers to a divalent group having the same structure as the C_1-C_{10} heterocycloalkenyl group.

[0227] The term "C_6-C_{60} aryl group" as used herein refers to a monovalent group having a carbocyclic aromatic system

having 6 to 60 carbon atoms, and the term "C_6-C_{60} arylene group" as used herein refers to a divalent group having a carbocyclic aromatic system having 6 to 60 carbon atoms. Non-limiting examples of the C_6-C_{60} aryl group include a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C_6-C_{60} aryl group and the C_6-C_{60} arylene group each include two or more rings, the rings may be fused to each other. Corresponding definitions apply to other ranges given for the number of carbon atoms in an aryl/arylene group.

[0228] The term "C_1-C_{60} heteroaryl group" as used herein refers to a monovalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. The term "C_1-C_{60} heteroarylene group" as used herein refers to a divalent group having a carbocyclic aromatic system that has at least one heteroatom selected from N, O, Si, P, and S as a ring-forming atom, in addition to 1 to 60 carbon atoms. Non-limiting examples of the C_1-C_{60} heteroaryl group include a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, and an isoquinolinyl group. When the C_1-C_{60} heteroaryl group and the C_1-C_{60} heteroarylene group each include two or more rings, the rings may be condensed with each other. Corresponding definitions apply to other ranges given for the number of carbon atoms in an heteroaryl/heteroarylene group.

[0229] The term "C_6-C_{60} aryloxy group" as used herein indicates -OA_{102} (wherein A_{102} represents the C_6-C_{60} aryl group), and the term "C_6-C_{60} arylthio group" as used herein indicates -SA_{103} (wherein A_{103} represents the C_6-C_{60} aryl group). Corresponding definitions apply to other ranges given for the number of carbon atoms in an aryloxy group and an arylthio group.

[0230] The term "monovalent non-aromatic condensed polycyclic group" as used herein refers to a monovalent group (for example, having 8 to 60 carbon atoms) having two or more rings condensed with each other, only carbon atoms as ring-forming atoms, and no aromaticity in its entire molecular structure. A non-limiting example of the monovalent non-aromatic condensed polycyclic group is a fluorenyl group. The term "divalent non-aromatic condensed polycyclic group" as used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

[0231] The term "monovalent non-aromatic condensed heteropolycyclic group" as used herein refers to a monovalent group (for example, having 1 to 60 carbon atoms) having two or more rings condensed to each other, at least one heteroatom selected from N, O, Si, P, and S, other than carbon atoms, as a ring-forming atom, and no aromaticity in its entire molecular structure. An example of the monovalent non-aromatic condensed heteropolycyclic group is a carbazolyl group. The term "divalent non-aromatic condensed heteropolycyclic group" as used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

[0232] The term "C_5-C_{60} carbocyclic group" as used herein refers to a monocyclic or polycyclic group having 5 to 60 carbon atoms in which a ring-forming atom is carbon atoms only. The C_5-C_{60} carbocyclic group may be an aromatic carbocyclic group or a non-aromatic carbocyclic group. The C_5-C_{60} carbocyclic group may be a ring, such as benzene, a monovalent group, such as a phenyl group, or a divalent group, such as a phenylene group. In one or more embodiments, depending on the number of substituents connected to the C_5-C_{60} carbocyclic group, the C_5-C_{60} carbocyclic group may be a trivalent group or a quadrivalent group. Corresponding definitions apply to other ranges given for the number of carbon atoms in a carbocyclic group.

[0233] The term "C_1-C_{60} heterocyclic group" as used herein refers to a group having the same structure as the C_1-C_{60} carbocyclic group, except that as a ring-forming atom, at least one heteroatom selected from N, O, Si, P, and S is used in addition to carbon (the number of carbon atoms may be in a range of 1 to 60). Corresponding definitions apply to other ranges given for the number of carbon atoms in a heterocyclic group.

[0234] At least one substituent of the substituted C_5-C_{60} (*e.g.* C_5-C_{30}) carbocyclic group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heterocyclic group, the substituted C_3-C_{10} cycloalkylene group, the substituted C_1-C_{10} heterocycloalkylene group, the substituted C_3-C_{10} cycloalkenylene group, the substituted C_1-C_{10} heterocycloalkenylene group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylene group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, the substituted C_2-C_{60} alkenyl group, the substituted C_2-C_{60} alkynyl group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, the substituted C_3-C_{10} cycloalkyl group, the substituted C_1-C_{10} heterocycloalkyl group, the substituted C_3-C_{10} cycloalkenyl group, the substituted C_1-C_{10} heterocycloalkenyl group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, the substituted C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryloxy group, the substituted C_1-C_{60} (*e.g.* C_1-C_{20}) heteroarylthio group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group may be selected from:

deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, and a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group;

a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, and a

C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{11})(Q_{12})(Q_{13}), - N(Q_{11})(Q_{12}), -B(Q_{11})(Q_{12}), -C(=O)(Q_{11}), -S(=O)$_2$(Q_{11}), and -P(=O)(Q_{11})(Q_{12});

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryloxy group, a C_6-C_{60} (*e.g.* C_6-C_{30}) arylthio group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{21})(Q_{22})(Q_{23}), -N(Q_{21})(Q_{22}), - B(Q_{21})(Q_{22}), -C(=O)(Q_{21}), -S(=O)$_2$(Q_{21}), and -P(=O)(Q_{21})(Q_{22}); and

-Si(Q_{31})(Q_{32})(Q_{33}), -N(Q_{31})(Q_{32}), -B(Q_{31})(Q_{32}), -C(=O)(Q_{31}), -S(=O)$_2$(Q_{31}), and -P(=O)(Q_{31})(Q_{32}), and

Q_{11} to Q_{13}, Q_{21} to Q_{23}, and Q_{31} to Q_{33} may each independently be selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkenyl group, a C_2-C_{60} (*e.g.* C_2-C_{20}) alkynyl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} (*e.g.* C_6-C_{30}) aryl group, a C_1-C_{60} (*e.g.* C_1-C_{20}) heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group.

[0235] The term "Ph" as used herein represents a phenyl group, the term "Me" as used herein represents a methyl group, the term "Et" as used herein represents an ethyl group, the term "ter-Bu" or "Bu^t," as used herein, represents a tert-butyl group, and the term "OMe" as used herein represents a methoxy group.

[0236] The term "biphenyl group" as used herein refers to a "phenyl group substituted with a phenyl group". The "biphenyl group" is a "substituted phenyl group" having a "C_6-C_{60} aryl group" as a substituent.

[0237] The term "terphenyl group" as used herein refers to a "phenyl group substituted with a biphenyl group. The "terphenyl group" is a "phenyl group" having, as a substituent, a "C_6-C_{60} aryl group substituted with a C_6-C_{60} aryl group."

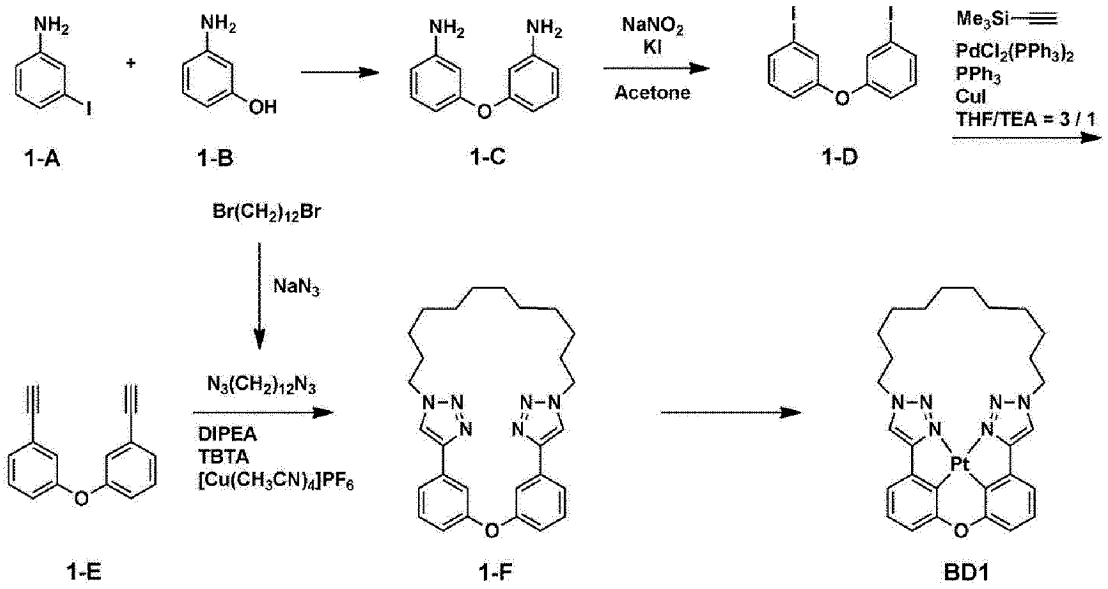
[0238] * and *' as used herein, unless defined otherwise, each refer to a binding site to a neighboring atom in a corresponding formula.

[0239] Hereinafter, a compound according to embodiments and an organic light-emitting device according to embodiments will be described in more detail with reference to Synthesis Examples and Examples. The expression "B was utilized instead of A" used in describing Synthesis Examples and Examples indicates that an identical number of molar equivalents of B was utilized in place of molar equivalents of A.

Synthesis Example

Synthesis Example 1: **Synthesis of Compound BD1**

[0240]



1) Synthesis of Intermediate 1-C

[0241] 3.96 g (36.0 mmol) of 3-aminophenol, 6.54 g (30.0 mmol) of 3-iodoaniline, 13.8 g (60.0 mmol) of potassium triphosphate, 1.14 g (6.0 mmol) of copper iodide, and 0.74 g (6.0 mmol) of picolinic acid were added to a reaction container and suspended in 60 ml of dimethyl sulfoxide. The reaction mixture was heated and stirred at a temperature 85 °C for 24 hours. After the reaction was completed, the reaction product was cooled to room temperature, and 300 ml of distilled water was added thereto. Then, an organic layer was extracted therefrom utilizing ethyl acetate. The extracted organic layer was washed utilizing a saturated sodium chloride aqueous solution and dried utilizing sodium sulfate. The solvent was removed therefrom, and a residue obtained therefrom was separated by column chromatography to obtain 5.40 g of Intermediate 1-C, which is a transparent oil.

2) Synthesis of Intermediate 1-D

[0242] 4.0 g (20.0 mmol) of the synthesized 3,3'-oxyaniline (Intermediate 1-C) was dissolved in 100 ml of acetone. An aqueous hydrochloric acid solution (21 ml of hydrochloric acid was diluted with 30 ml of distilled water) was added dropwise thereto. The reaction solution was cooled to a temperature of 0 °C, and 8.4 g (121.8 mmol) of sodium nitrite was dissolved in 50 ml of distilled water and slowly added dropwise thereto. The solution was stirred at a temperature of 0 °C for 1 hour, 25 g (150.6 mmol) of potassium iodide was dissolved in 50 ml of distilled water and added dropwise thereto. The reaction mixture was stirred at a temperature of 0 °C for 2 hours, heated to a temperature of 60 °C, and additionally stirred for 4 hours.

[0243] Sodium bisulfite was added thereto to remove the residual iodine, and the reaction mixture was concentrated under reduced pressure. The residue obtained therefrom was extracted utilizing dimethylchloride, and an organic layer was dried utilizing magnesium sulfate. Then, the product obtained therefrom was purified by column chromatography to obtain 6.0 g of Intermediate 1-D, which is a white solid.

3) Synthesis of Intermediate 1-E

[0244] 5.6 g (13.3 mmol) of the synthesized 3,3'-oxybis(iodobenzene) (Intermediate 1-D), 5.2 ml (36.8 mmol) of trimethylsilylacetylene, 0.94 g (1.34 mmol) of $PdCl_2(PPh_3)_2$, 0.7 g (2.67 mmol) of triphenylphosphine, 0.38 g (2.00 mmol) of copper iodide, and 80 ml of a mixed solvent of tetrahydrofuran/triethylamine (v/v = 3:1) were added to a 250-ml reaction container and stirred for 12 hours. After the reaction was completed, the reaction product was concentrated under reduced pressure, and an organic layer was extracted therefrom utilizing an aqueous solution of methylene chloride and ammonium chloride. The organic layer was washed utilizing distilled water and brine. The organic layer was dried utilizing magnesium sulfate and purified by column chromatography (methylene chloride: n-hexane = 1:9). The obtained white solid was dissolved in 40 ml of tetrahydrofuran, and 1.0 M solution of tetrabutylammonium fluoride was added thereto and stirred for 12 hours. The reaction mixture was concentrated under reduced pressure, and the product was extracted therefrom utilizing methylene chloride. The product was dried utilizing magnesium sulfate and purified by chromatography (methylene chloride:n-hexane = 1:9) to obtain 2.55 g of Intermediate 1-E that is a white solid.

4) Synthesis of Intermediate 1-F

[0245] 0.4 g (1.83 mmol) of the synthesized 3,3'-oxybis(ethynylbenzene) (Intermediate 1-E), 0.49 g (1.92 mmol) of 1,12-diazidododecane, 0.95 g (7.32 mmol) of disopropylamine, tris[(1-benzyl-1H-1,2,3-triazol-4-yl)methyl]amine (1 mol%), and 240 ml of dichloromethane were added to a 500-ml reaction container and bubbled with nitrogen gas for 30 minutes. $[Cu(CH_3CN)_4]PF_6$ (1 mol%) was added as a catalyst and stirred at room temperature for 6 days. The solvent was removed under reduced pressure, and the residue obtained therefrom was dissolved in dichloromethane and washed several times with saturated ammonium chloride, distilled water, and saturated sodium chloride aqueous solution. An organic layer was dried utilizing magnesium sulfate, and the residue obtained therefrom was purified by column chromatography (methylenechloride:ethyl acetate = 5:1) to obtain 0.2 g Intermediate 1-F.

5) Synthesis of Compound BD1

[0246] 0.8 g of the synthesized ligand Intermediate 1-F, 0.06 g of tetrabutylammonium bromide, and 0.8 g of K_2PtCl_4 were added to a reaction container and 100 ml of acetic acid was added thereto. The reaction mixture was stirred at room temperature for 1 day and stirred at a temperature of 140 °C for 4 days. 100 ml of distilled water was added thereto, and the resulting solid was filtered under reduced pressure. The solid was dissolved in methylene chloride and washed utilizing distilled water and saturated sodium chloride. An organic layer was dried utilizing magnesium sulfate and purified by column chromatography utilizing methylene chloride to obtain Compound BD1.

Synthesis Example 2: Synthesis of Compound BD2

[0247] Compound BD2 was obtained in the same manner as in Synthesis Example 1, except that 3-amino-5-methylphenol was utilized instead of 3-aminophenol, and 3-iodo-5-methylaniline was utilized instead of 3-iodoaniline.

Synthesis Example 3: Synthesis of Compound BD3

[0248] Compound BD3 was obtained in the same manner as in Synthesis Example 1, except that 3-amino-5-tert-butylphenol was utilized instead of 3-aminophenol, and 3-iodo-5-tertiarybutylaniline was utilized instead of 3-iodoaniline.

Synthesis Example 4: Synthesis of Compound BD4

[0249] Compound BD4 was obtained in the same manner as in Synthesis Example 1, except that 3-amino-5-trimethylsilylphenol was utilized instead of 3-aminophenol, and 3-iodo-5-trimethylsilyl aniline was utilized instead of 3-iodoaniline.

Synthesis Example 5: Synthesis of Compound BD5

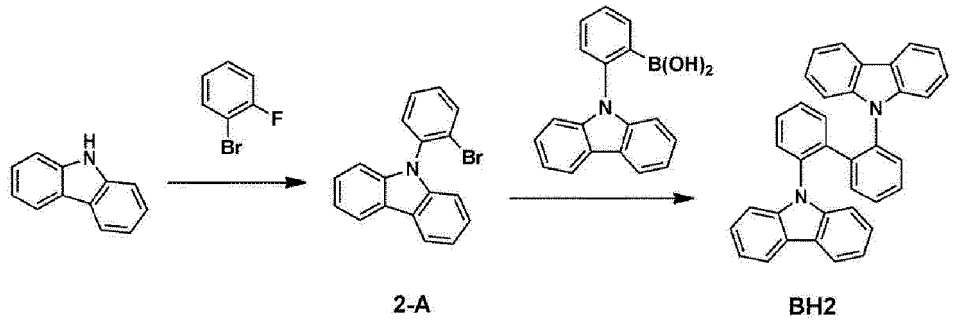
[0250] Compound BD5 was obtained in the same manner as in Synthesis Example 1, except that 3-amino-5-fluorophenol was utilized instead of 3-aminophenol, and 3-fluoro-5-iodoaniline was utilized instead of 3-iodoaniline.

Synthesis Example 6: Synthesis of Compound BD12

[0251] Compound BD12 was obtained in the same manner as in Synthesis Example 1, except that 1-azido-2-{2-[2-(2-azidoethoxy)ethoxy]ethoxy}ethane was utilized instead of 1,12-diazidododecane.

Synthesis Example 7 : Synthesis of Compound BH2

[0252]



2-A BH2

1) Synthesis of Intermediate 2-A

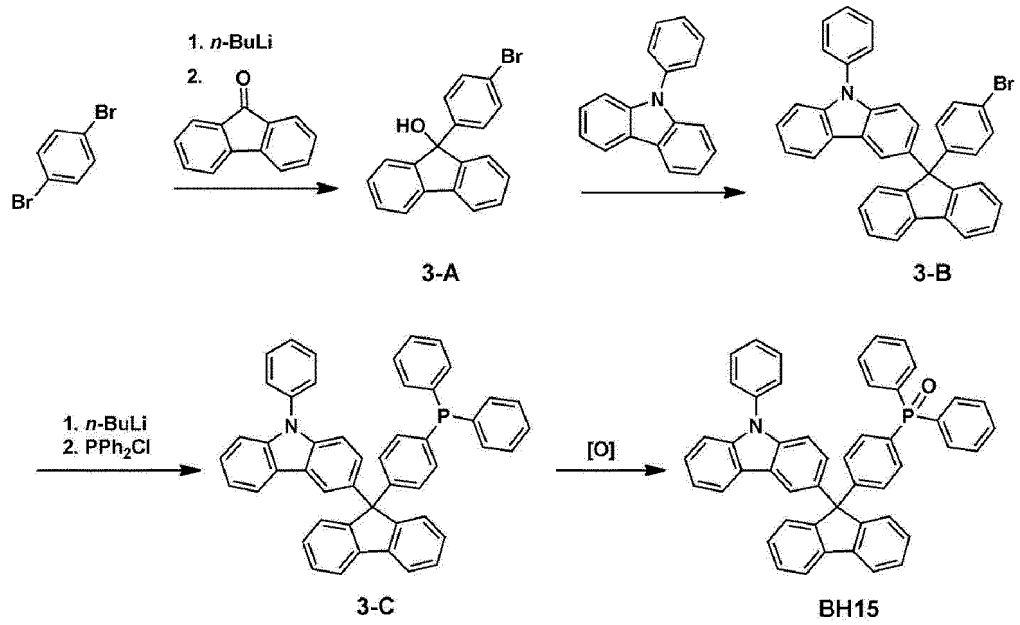
[0253] 15 g (89.7 mmol) of carbazole, 38 g (179.4 mmol) of potassium phosphate, and 20 ml (179.4 mmol) of 1-bromo-2-fluorobenzene were suspended in 300 ml of dimethylformamide, heated to a temperature of 160 °C, and stirred for 12 hours. Distilled water and methylene chloride were added to the reaction mixture and washed several times utilizing saturated sodium chloride. The product obtained therefrom was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:n-hexane = 5:95) to obtain 23 g of Intermediate 2-A.

2) Synthesis of Compound BH2

[0254] 0.50 g (1.55 mmol) of synthesized Intermediate [2-A], 0.53 g (1.85 mmol) of 2-((9H-carbazole-9-yl)phenyl) boronic acid, 0.26 g (1.85 mmol) of potassium carbonate, and 4 mol% of tetrakistriphenylphosphine palladium catalyst were suspended in 10 ml of a mixed solvent of toluene and ethanol (4:1), heated to a temperature of 120 °C, and stirred for 12 hours. Distilled water and dimethylchloride were added to the reaction mixture, and the product obtained therefrom was extracted therefrom and dried utilizing magnesium sulfate and purified by column chromatography to obtain 0.5 g of Compound BH2.

Synthesis Example 8 : Synthesis of Compound BH15

[0255]



3-A 3-B 3-C BH15

1) Synthesis of Intermediate 3-A

[0256] 15 g (63.59 mmol) of 1,4-dibromobenzene was dissolved in 200 ml of tetrahydrofuran and cooled to a temperature of -78 °C. 25 ml (63.59 mmol) of 2.5 M solution of n-butyllithium was added thereto and stirred for 1 hour.

11.5 g (63.59 mmol) of 9-fluorenone was dissolved in 50 ml of tetrahydrofuran and added dropwise to the reaction mixture. The reaction mixture was heated and stirred at room temperature for 12 hours, and distilled water and ethyl acetate were added thereto. The product was extracted therefrom and washed several times utilizing saturated sodium chloride. The product was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:n-hexane = 1:4) to obtain 19 g of Intermediate 3-A.

2) Synthesis of Intermediate 3-B

[0257] 15.7 g (64.58 mmol) of the synthesized Intermediate 3-A and 15.6 g (64.58 mmol) of phenylcarbazole were dissolved in 350 ml of methylene chloride and cooled to a temperature of 0 °C, and 1.5 ml of Eaton's reagent was added dropwise thereto and stirred for 1 hour. Distilled water and ethyl acetate were added thereto, and the product was extracted therefrom and washed several times utilizing saturated sodium chloride. The product obtained therefrom was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:n-hexane = 1:9) to obtain 13.8 g of Intermediate 3-B.

3) Synthesis of Intermediate 3-C

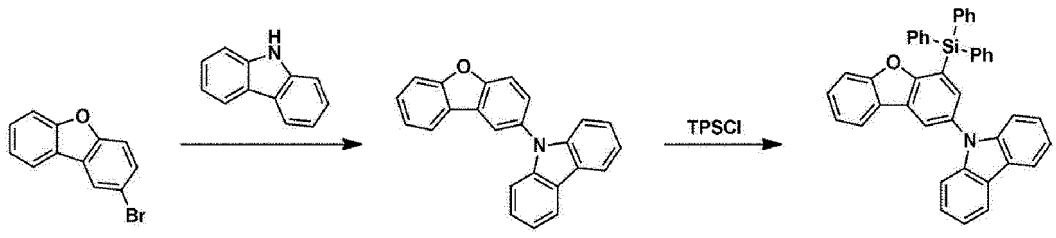
[0258] 13.8 g (24.5 mmol) of the synthesized Intermediate 3-B was dissolved in 150 ml of tetrahydrofuran and cooled to a temperature of -78 °C, and 12.8 ml of 2.5 M solution of n-butyllithium was added thereto and stirred for 2 hour. 6.5 ml of diphenylphosphine chloride was added dropwise thereto and heated and stirred at room temperature for 12 hours. Distilled water and ethyl acetate were added thereto, and a product was extracted therefrom and washed several times utilizing saturated sodium chloride. The product obtained therefrom was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:ethyl acetate = 1:9) to obtain Intermediate 3-C.

4) Synthesis of Compound BH15

[0259] The synthesized Intermediate 3-C was dissolved in 300 ml of dimethylchloride and 60 ml of hydrogen peroxide was added thereto and stirred for 30 minutes. Distilled water was added thereto, and a product was extracted therefrom and washed several times utilizing saturated sodium hydrogen carbonate aqueous solution. The product obtained therefrom was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:ethyl acetate = 1:9) to obtain 7.7 g of Compound BH15.

Synthesis Example 9 : **Synthesis of Compound BH4**

[0260]



4-A BH4

1) Synthesis of Intermediate 4-A

[0261] 5.9 g (23.79 mmol) of 2-bromodibenzofuran, carbazole (23.79 mmol), 1.14 g (0.3 mol%) of copper iodide, 1.3 g (0.3 mol%) of 1,10-phenanthroline, and 6.6 g (47.58 mmol) of potassium carbonate were suspended in 120 ml of dimethylformanide. The reaction mixture was heated and stirred under reflux for 24 hours. The reaction mixture was cooled to room temperature, and the reaction mixture was added dropwise to distilled water and solidified. The solid obtained therefrom was filtered and dried. The dried solid was purified by column chromatography (methylene chloride:n-hexane = 1:9) to obtain 8.0 g of Intermediate 4-A.

2) Synthesis of Compound BH4

[0262] 8 g (16.50 mmol) of the synthesized Intermediate 4-A was dissolved in 80 ml of tetrahydrofuran and cooled to a

temperature of -78 °C, and 8 ml (19.80 mmol) of 2.5 M solution of n-butyllithium was added thereto and stirred for 1 hour. 5.84 g (19.80 mmol) of triphenylsilyl chloride was dissolved in 20 ml of tetrahydrofuran and added dropwise to the reaction mixture. The reaction mixture was heated and stirred at room temperature for 12 hours, and distilled water and ethyl acetate were added thereto to extract the product. The product was dried utilizing magnesium sulfate and purified by column chromatography (dichloromethane:n-hexane = 1:4) to obtain 9.3 g of Compound BH4.

Examples

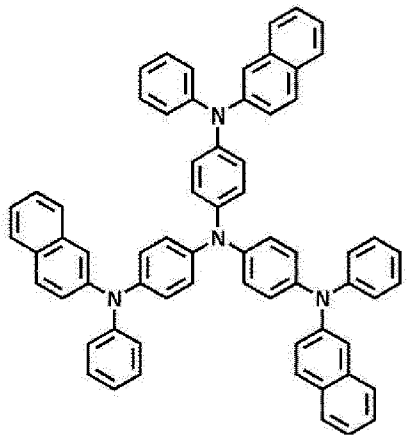
Example 1 (not forming part of the claimed invention)

[0263] As a substrate and an ITO anode, a glass substrate, on which a Corning 15 Ω/cm^2 (1,200 Å) ITO was formed, was cut into a size of 50 mm x 50 mm x 0.7 mm, sonicated with isopropyl alcohol and pure water each for 5 minutes, and then cleaned by exposure to ultraviolet rays and ozone for 30 minutes. Then, the glass substrate was provided to a vacuum deposition apparatus.

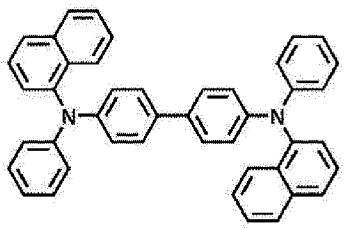
[0264] 2-TNATA was vacuum-deposited on the ITO anode formed on the glass substrate to form a hole injection layer having a thickness of 600 Å, and NPB was vacuum-deposited on the hole injection layer to form a hole transport layer having a thickness of 300 Å.

[0265] Compound BH1 (host) and Compound BD1 (dopant) were co-deposited on the hole transport layer at a host-to-dopant weight ratio of 90:10 to form an emission layer having a thickness of 300 Å.

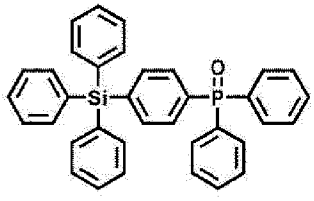
[0266] TSP01 was deposited on the emission layer to form a hole blocking layer having a thickness of 50 Å, Alq_3 was deposited on the hole blocking layer to form an electron transport layer having a thickness of 300 Å, LiF was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vacuum-deposited on the electron injection layer to form a cathode having a thickness of 3,000 Å, thereby completing the manufacture of an organic light-emitting device.



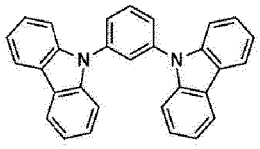
2-TNATA



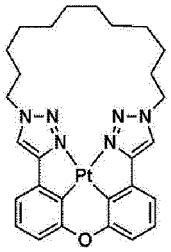
NPB



TSPO1



BH1



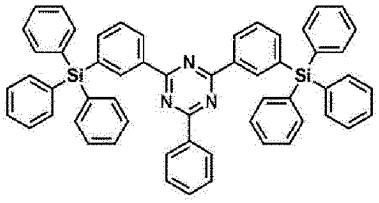
BD1

Examples 2 to 9 (Example 2 does not form part of the claimed invention)

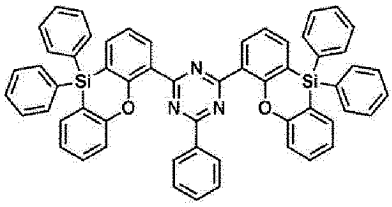
[0267] Organic light-emitting devices were manufactured in the same manner as in Example 1, except that Compounds shown in Table 1 were each utilized in forming an emission layer instead of Compound BD1 (dopant) and Compound BH1 (host) utilized in Example 1.

Example 11

[0268] As an anode, a glass substrate, on which a Corning 15 Ω/cm^2 (1,200 Å) ITO was formed, was cut into a size of 50 mm x 50 mm x 0.7 mm, sonicated with isopropyl alcohol and pure water each for 5 minutes, and then cleaned by exposure to ultraviolet rays and ozone for 30 minutes. Then, the glass substrate was provided to a vacuum deposition apparatus. Known Compound 2-TNATA was vacuum-deposited on the glass substrate to form a hole injection layer having a thickness of 600 Å, and NPB as a hole transport compound was vacuum-deposited to form a hole transport layer having a thickness of 300 Å. Compound BD1 for a blue fluorescent emission layer was co-deposited on the hole transport layer with a mixed host having a dopant ratio of 10% and an ETH1:BH1 weight ratio of 1:9 to form an emission layer having a thickness of 300 Å. Then, ETH1 was vacuum-deposited to form a hole blocking layer having a thickness of 50 Å. Alq_3 was deposited on the emission layer (e.g., deposited on the hole blocking layer which was deposited on the emission layer) to form an electron transport layer having a thickness of 300 Å. LiF, which is an alkali metal halide, was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vacuum-deposited to form a cathode electrode having a thickness of 3,000 Å and to form an LiF/Al electrode, thereby completing the manufacture of an organic light-emitting device.



ETH1



ETH2

Example 12

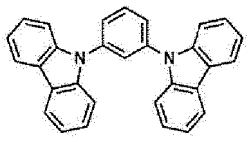
[0269] An organic light-emitting device was manufactured in the same manner as in Example 11, except that ETH2 was utilized instead of ETH1 as a host.

Comparative Example 1

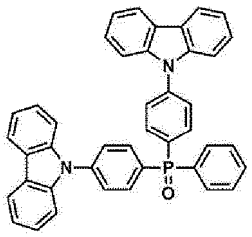
[0270] As a substrate and an ITO anode, a glass substrate, on which a Corning 15Ω/cm^2 (1,200 Å) ITO was formed, was cut into a size of 50 mm x 50 mm x 0.7 mm, sonicated with isopropyl alcohol and pure water each for 5 minutes, and then cleaned by exposure to ultraviolet rays and ozone for 30 minutes. Then, the glass substrate was provided to a vacuum deposition apparatus.

[0271] NPB was vacuum-deposited on the ITO anode formed on the glass substrate to form a hole transport layer having a thickness of 300 Å. mCP was deposited on the hole transport layer to form an electron blocking layer having a thickness of 60 Å. BCPO (host) and Compound BD1 (dopant) were co-deposited on the electron blocking layer at a host-to-dopant weight ratio of 90:10 to form an emission layer having a thickness of 300 Å.

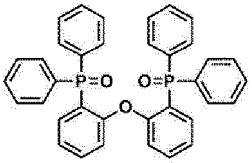
[0272] DPEPO was deposited on the emission layer to form a hole blocking layer having a thickness of 50 Å, Alq_3 was deposited on the hole blocking layer to form an electron transport layer having a thickness of 300 Å, LiF was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vacuum-deposited on the electron injection layer to form a cathode having a thickness of 3,000 Å, thereby completing the manufacture of an organic light-emitting device.



mCP



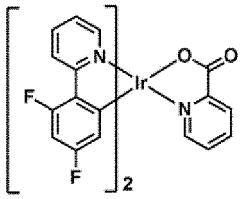
BCPO



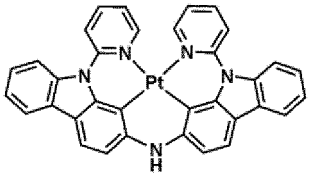
DPEPO

Comparative Examples 2 to 4

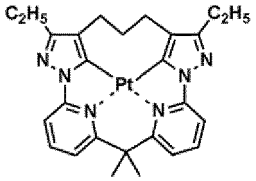
[0273] Organic light-emitting devices were manufactured in the same manner as in Example 1, except that Compounds shown in Table 1 were each utilized to form an emission layer instead of Compound BD1 and BCPO utilized in Example 1.



A



B



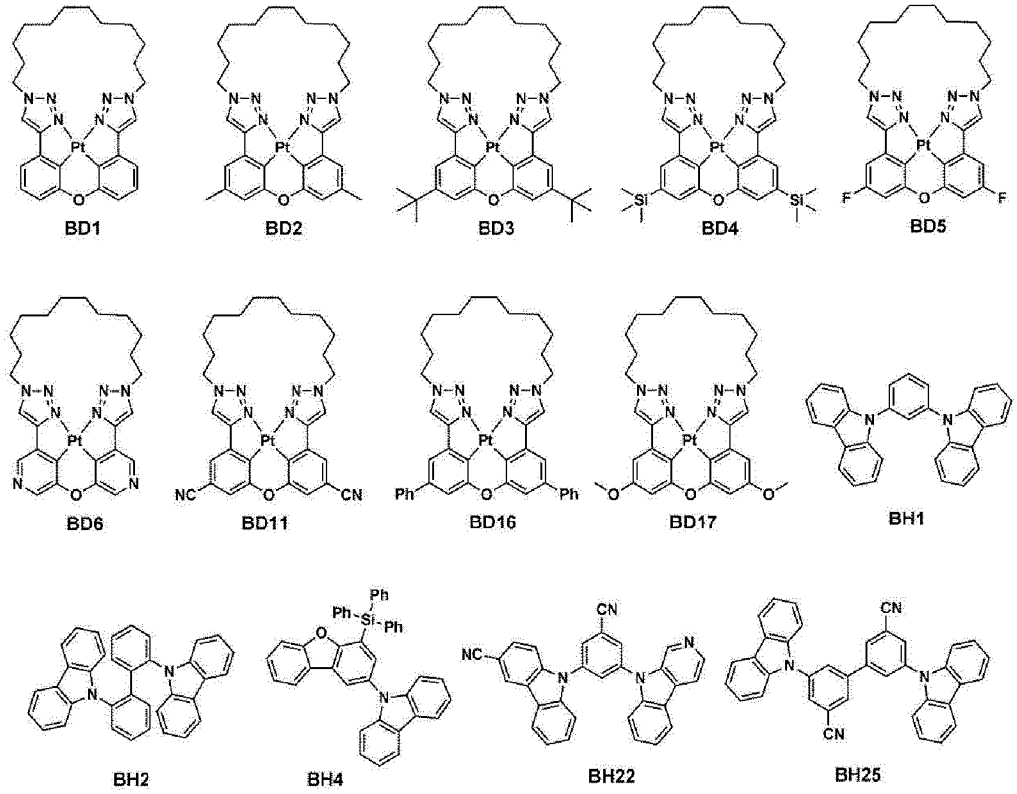
C

Evaluation Example 1

[0274] The driving voltage, current density, luminance, luminescent efficiency, and maximum emission wavelength of the organic light-emitting devices manufactured according to Examples 1 to 12 and Comparative Examples 1 to 4 were measured utilizing Keithley SMU 236 and a luminance meter PR650, and results thereof are shown in Table 1.

Table 1

	Dopant compound	Host compound	Driving voltage (V)	Current density (mA/cm^2)	Luminance (cd/m^2)	Luminescent efficiency (cd/A)	Maximum emission wavelength (nm)	Lifespan (T90, h)
Example 1	BD1	BH1	4.9	6.5	1000	20.1	453	7.0
Example 2	BD2	BH1	4.7	6.4	1000	17.2	457	3.0
Example 3	BD3	BH2	4.3	6.4	1000	15.1	457	11.0
Example 4	BD4	BH2	4.3	5.8	1000	16.2	457	11.1
Example 5	BD5	BH4	4.3	5.6	1000	16.7	456	15.4
Example 6	BD6	BH4	4.3	5.1	1000	15.3	457	5.5
Example 7	BD11	BH4	4.4	5.5	1000	19.2	457	4.5
Example 8	BD16	BH22	4.4	5.6	1000	18.4	455	7.8
Example 9	BD17	BH25	4.3	5.2	1000	16.9	456	9.1
Example 11	BD1	BH1, ETH1	4.4	5.2	1000	16.2	457	21.0
Example 12	BD1	BH1, ETH2	4.4	5.2	1000	16.5	455	24.0
Comparative Example 1	BD1	BCPO	5.5	14.2	1000	6.6	451	0.3
Comparative Example 2	A	BH1	5.2	9.9	1000	6.5	488	0.1
Comparative Example 3	B	BH1	5.2	9.3	1000	10.7	478	0.1
Comparative Example 4	C	BH1	5.7	8.8	1000	8.2	478	0.1



[0275] Referring to Table 1, it is confirmed that the organic light-emitting devices of Examples 1 to 12 have a low driving voltage, high luminescent efficiency, and excellent lifespan, as compared with the organic light-emitting devices of Comparative Examples 1 to 4.

[0276] The organic light-emitting device may have a low driving voltage, a high efficiency, and a long lifespan.

[0277] It should be understood that embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

[0278] While one or more embodiments have been described with reference to the drawing, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the scope as defined by the following claims.

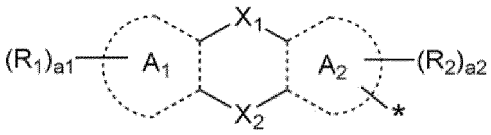
Claims

1. An organic light-emitting device (10) comprising:

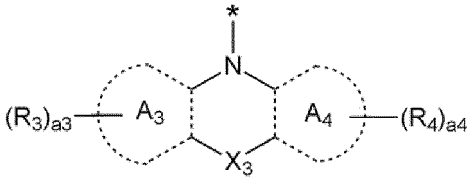
a first electrode (110);
a second electrode (190) facing the first electrode (110); and
an organic layer (150) between the first electrode (110) and the second electrode (190) and comprising an emission layer,
wherein the emission layer comprises a host and a dopant, the host comprises a first compound represented by Formula 1 and the dopant comprises a second compound represented by Formula 2A or 2B, and
the first compound is not 1,3-di-9-carbazolylbenzene (mCP):

Formula 1 $(CY_1)_{m1}$-$(L_1)_{b1}$-$(CY_2)_{m2}$

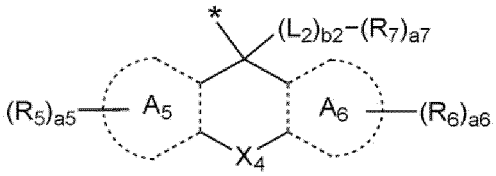
Formula 1-1



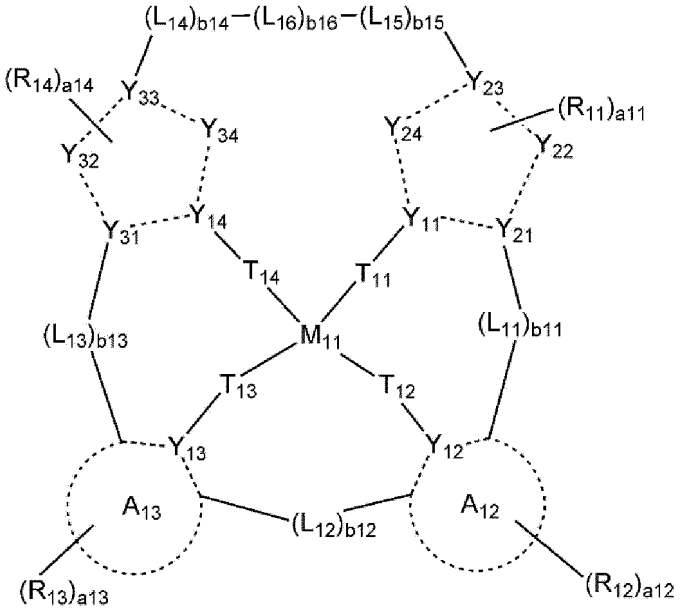
Formula 1-2



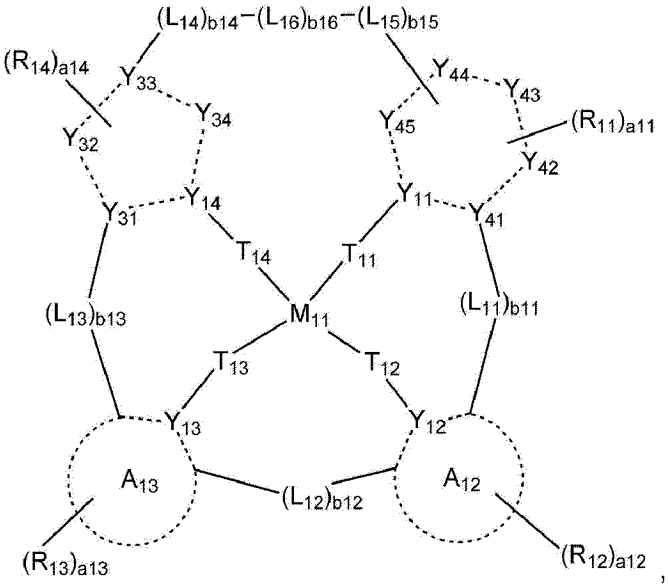
Formula 1-3



Formula 2A



Formula 2B



wherein, in Formulae 1, 1-1, 1-2, and 1-3,

CY_1 and CY_2 are each independently a group represented by one of Formulae 1-1, 1-2, and 1-3,

m1 and m2 are each independently 0, 1 or 2, wherein a sum of m1 and m2 is 2,

L_1 and L_2 are each independently selected from a substituted or unsubstituted C_3-C_{10} cycloalkylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3-C_{10} cycloalkenylene group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6-C_{60} arylene group, a substituted or unsubstituted C_1-C_{60} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group, and -Si(Q_1)(Q_2)-,

b1 is an integer from 0 to 5,

b2 is an integer from 0 to 4,

X_1 to X_4 are each independently selected from a single bond, *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_a)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*', and *-Si(R_8)(R_9)-*',

rings A_1 to A_6 are each independently a C_5-C_{60} carbocyclic group or a C_2-C_{60} heterocyclic group,

R_1 to R_9 are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a substituted or unsubstituted C_1-C_{60} alkyl group, a substituted or unsubstituted C_2-C_{60} alkenyl group, a substituted or unsubstituted C_2-C_{60} alkynyl group, a substituted or unsubstituted C_1-C_{60} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, - Si(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), - S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2), and -P(=S)(Q_1)(Q_2),

a1 to a7 are each independently an integer from 1 to 8,

in Formulae 2A and 2B,

M_{11} is selected from platinum (Pt), palladium (Pd), copper (Cu), silver (Ag), gold (Au), rhodium (Rh), iridium (Ir), ruthenium (Ru), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), and thulium (Tm),

A_{12} and A_{13} are each independently selected from a C_5-C_{60} carbocyclic group and a C_1-C_{60} heterocyclic group,

Y_{11} to Y_{14} are each independently N or C,

Y_{21} to Y_{24} are each independently N or C,

Y_{31} to Y_{34} are each independently N or C, and

Y_{41} to Y_{45} are each independently N or C,

T_{11} to T_{14} are each independently selected from a single bond, O, and S,

L_{11} to L_{13} are each independently selected from a single bond, *-O-*', *-S-*', *-C(R_{15})(R_{16})-*', *-C(R_{15})=*', *=C(R_{15})-*', *-C(R_{15})=C(R_{16})-*', *-C(=O)-*', *-C(=S)-*', *-C≡C-*', *-B(R_{15})-*', *-N(R_{15})-*', *-P(R_{15})-*', *-Si(R_{15})(R_{16})-*', *-P(=O)(R_{15})(R_{16})-*', and *-Ge(R_{15})(R_{16})-*',

b11 to b13 are each independently an integer from 0 to 3,

when b11 is 0, Y_{21} or Y_{41} is not linked to A_{12}, when b12 is 0, A_{12} and A_{13} are not linked to each other, and when b13 is 0, A_{13} and Y_{31} are not linked to each other,

L_{14} to L_{16} are each independently selected from *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{17})-*', *-N(R_{17})-*', *-P(R_{17})-*', *-Si(R_{17})(R_{18})-*', *-P(=O)(R_{17})(R_{18})-*', *-Ge(R_{17})(R_{18})-*', a divalent C_2-C_{20} hydrocarbon group, a divalent C_5-C_{60} carbocyclic group, and a divalent C_1-C_{60} heterocyclic group,

b14 and b15 are each independently an integer from 1 to 5,

b16 is an integer from 0 to 5,

when b16 is 0, L_{16} is a single bond,

R_{11} to R_{18} are each independently selected from hydrogen, deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a substituted or unsubstituted C_1-C_{60} alkyl group, a substituted or unsubstituted C_2-C_{60} alkenyl group, a substituted or unsubstituted C_2-C_{60} alkynyl group, a substituted or unsubstituted C_1-C_{60} alkoxy group, a substituted or unsubstituted C_3-C_{10} cycloalkyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3-C_{10} cycloalkenyl group, a substituted or unsubstituted C_1-C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6-C_{60} aryl group, a substituted or unsubstituted C_6-C_{60} aryloxy group, a substituted or unsubstituted C_6-C_{60} arylthio group, a substituted or unsubstituted C_1-C_{60} heteroaryl group, a substituted or unsubstituted C_1-C_{60} heteroaryloxy group, a substituted or unsubstituted C_1-C_{60} heteroarylthio group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_1)(Q_2)(Q_3), - B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), - P(=O)(Q_1)(Q_2), and -P(=S)(Q_1)(Q_2),

R_{15} and R_{11}; R_{15} and R_{12}; R_{15} and R_{13}; or R_{15} and R_{14} are optionally linked to form a substituted or unsubstituted C_5-C_{60} carbocyclic group or a substituted or unsubstituted C_1-C_{60} heterocyclic group,

a11 to a14 are each independently an integer from 1 to 8,

* and *' each indicate a binding site to a neighboring atom,

at least one substituent of the substituted C_3-C_{10} cycloalkylene group, the substituted C_1-C_{10} heterocycloalkylene group, the substituted C_3-C_{10} cycloalkenylene group, the substituted C_1-C_{10} heterocycloalkenylene group, the substituted C_6-C_{60} arylene group, the substituted C_1-C_{60} heteroarylene group, the substituted divalent non-aromatic condensed polycyclic group, the substituted divalent non-aromatic condensed heteropolycyclic group, the substituted C_1-C_{60} alkyl group, the substituted C_2-C_{60} alkenyl group, the substituted C_2-C_{60} alkynyl group, the substituted C_1-C_{60} alkoxy group, the substituted C_3-C_{10} cycloalkyl group, the substituted C_1-C_{10} heterocycloalkyl group, the substituted C_3-C_{10} cycloalkenyl group, the substituted C_1-C_{10} heterocycloalkenyl group, the substituted C_6-C_{60} aryl group, the substituted C_6-C_{60} aryloxy group, the substituted C_6-C_{60} arylthio group, the substituted C_1-C_{60} heteroaryl group, the substituted monovalent non-aromatic condensed polycyclic group, and the substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group;

a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, and a C_1-C_{60} alkoxy group, each substituted with at least one selected from deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, -Si(Q_{11})(Q_{12})(Q_{13}), -N(Q_{11})(Q_{12}), -B(Q_{11})(Q_{12}), -C(=O)(Q_{11}), - S(=O)$_2$(Q_{11}), and -P(=O)(Q_{11})(Q_{12});

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, a biphenyl group, and a terphenyl group;

a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a

hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryloxy group, a C_6-C_{60} arylthio group, a C_1-C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group excluding a carbazolyl group, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-N(Q_{21})(Q_{22})$, $-B(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$, and $-P(=O)(Q_{21})(Q_{22})$, and
$-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$, and $-P(=O)(Q_{31})(Q_{32})$, and
Q_1 to Q_3, Q_{11} to Q_{13}, Q_{21} to Q_{23}, and Q_{31} to Q_{33} are each independently selected from hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amidino group, a hydrazino group, a hydrazono group, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a C_3-C_{10} cycloalkyl group, a C_1-C_{10} heterocycloalkyl group, a C_3-C_{10} cycloalkenyl group, a C_1-C_{10} heterocycloalkenyl group, a C_6-C_{60} aryl group, a C_6-C_{60} aryl group substituted with a C_1-C_{60} alkyl group, a C_6-C_{60} aryl group substituted with a C_6-C_{60} aryl group, a terphenyl group, a C_1-C_{60} heteroaryl group, a C_1-C_{60} heteroaryl group substituted with a C_1-C_{60} alkyl group, a C_1-C_{60} heteroaryl group substituted with a C_6-C_{60} aryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

2. An organic light-emitting device (10) according to claim 1, wherein
L_1 and L_2 in Formulae 1, 1-1, 1-2, and 1-3 are each independently selected from:

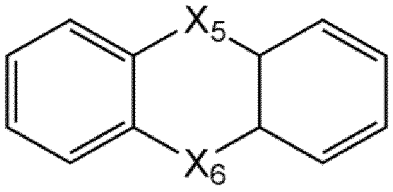
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group;
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and
$-Si(Q_4)(Q_5)-$, and
Q_4 and Q_5 are each independently selected from:

a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and
a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

3. An organic light-emitting device (10) according to claim 1 or claim 2, wherein

A_1 to A_6 in Formulae 1-1, 1-2, and 1-3 are each independently selected from a benzene ring, a naphthalene ring, a pyridine ring, a pyrimidine ring, a pyrazine ring, a pyridazine ring, a triazine ring, a quinoline ring, an isoquinoline ring, a quinoxaline ring, a quinazoline ring, and a ring represented by Formula 4:

Formula 4



wherein, in Formula 4,
X_5 and X_6 are each independently selected from *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_8)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*', and *-Si(R_8)(R_9)-*', and
R_8 and R_9 are the same as described in connection with Formulae 1, 1-1, 1-2, and 1-3.

4. An organic light-emitting device (10) according to any one of claims 1 to 3, wherein
R_1 to R_9 in Formulae 1-1, 1-2 and 1-3 are each independently selected from:

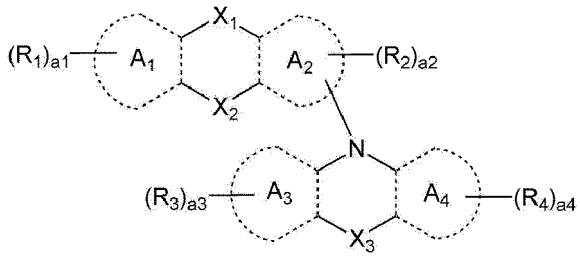
hydrogen, deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{60} alkyl group, a C_2-C_{60} alkenyl group, a C_2-C_{60} alkynyl group, a C_1-C_{60} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a terphenyl group;
a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a terphenyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, ter-butyl group, pentyl group, an isoamyl group, a hexyl group, a C_1-C_{60} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a naphthyl group, a fluorenyl group, a pyrenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrazolyl group, an imidazolyl group, a benzimidazolyl group, a pyridinyl group, a pyrimidyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a biphenyl group, and a terphenyl group; and
-Si(Q_4)(Q_5)(Q_6) and -P(=O)(Q_4)(Q_5), and
Q_4 to Q_6 are each independently selected from:

a C_1-C_{10} alkyl group, a C_1-C_{10} alkoxy group, and a phenyl group; and
a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, and a naphthyl group.

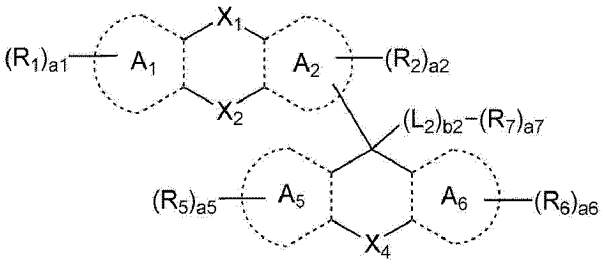
5. An organic light-emitting device (10) according to any one of claims 1 to 4, wherein

the first compound is a compound represented by one of Formulae 1A, 1B, and 1C:

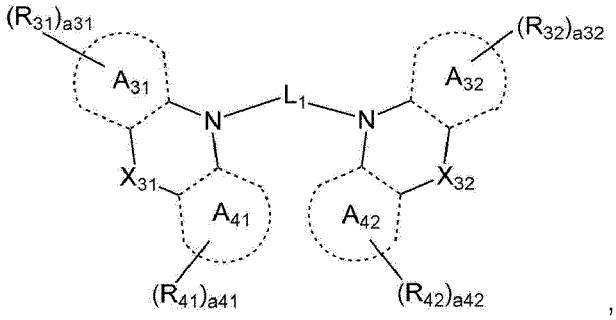
Formula 1A



Formula 1B



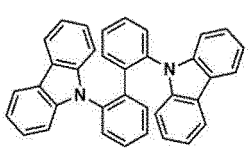
Formula 1C



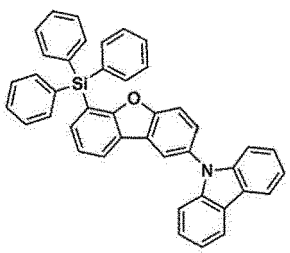
,

wherein, in Formulae 1A, 1B, and 1C,
X_1 to X_4, A_1 to A_6, L_1, L_2, b2, R_1 to R_7, and a1 to a7 are the same as described in connection with Formulae 1, 1-1, 1-2, and 1-3,
X_{31} and X_{32} are each independently the same as described in connection with X_3 in Formulae 1, 1-1, 1-2, and 1-3,
A_{31} and A_{32} are each independently the same as described in connection with A_3 in Formulae 1, 1-1, 1-2, and 1-3,
A_{41} and A_{42} are each independently the same as described in connection with A_4 in Formulae 1, 1-1, 1-2, and 1-3,
R_{31} and R_{32} are each independently the same as described in connection with R_3 in Formulae 1, 1-1, 1-2, and 1-3,
R_{41} and R_{42} are each independently the same as described in connection with R_4 in Formulae 1, 1-1, 1-2, and 1-3,
a31 and a32 are each independently the same as described in connection with a3 in Formulae 1, 1-1, 1-2, and 1-3, and
a41 and a42 are each independently the same as described in connection with a4 in Formulae 1, 1-1, 1-2, and 1-3.

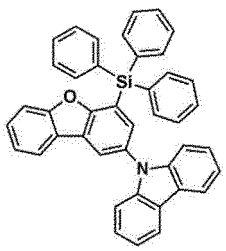
6. An organic light-emitting device (10) according to any one of claims 1 to 5, wherein the first compound is selected from Compounds BH2 to BH28:



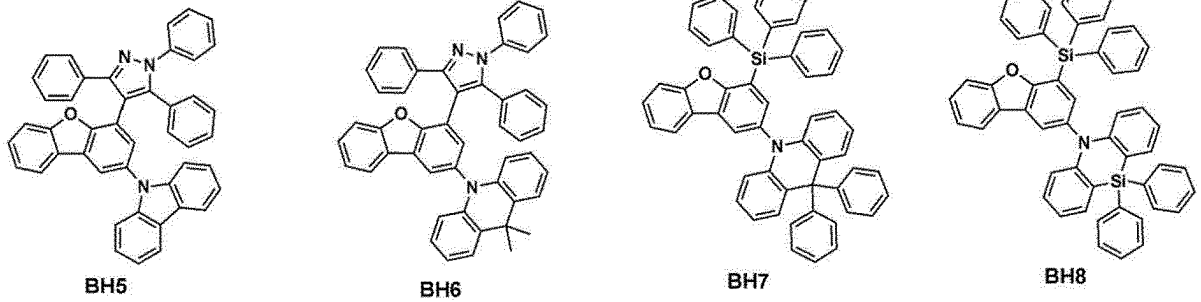
BH2



BH3



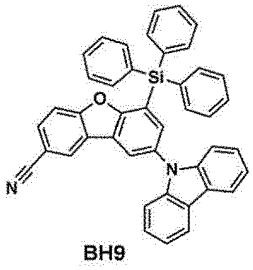
BH4

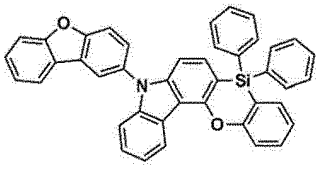

BH5

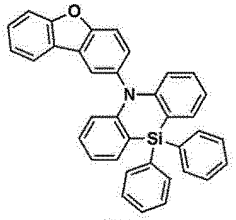
BH6

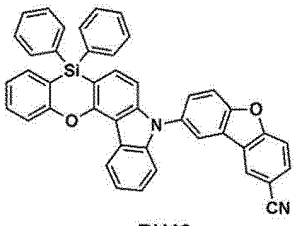
BH7

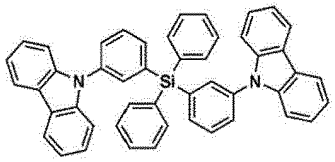
BH8

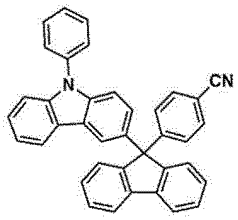

BH9

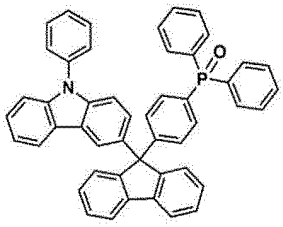

BH10

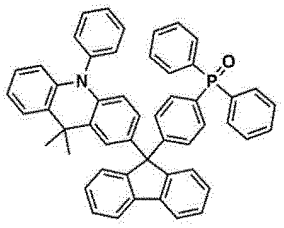

BH11

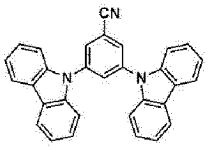

BH12

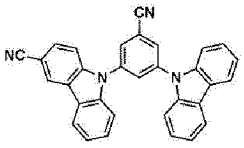

BH13

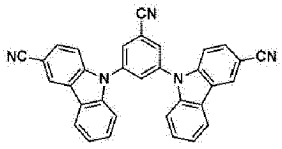

BH14

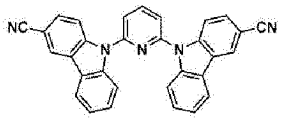

BH15

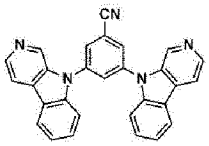

BH16

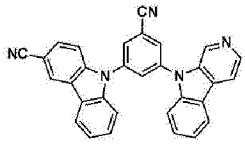

BH17

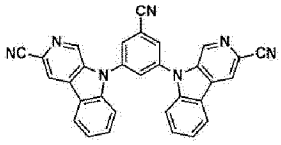

BH18

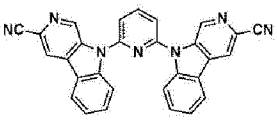

BH19

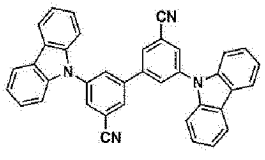

BH20

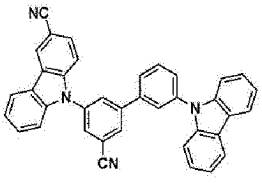

BH21

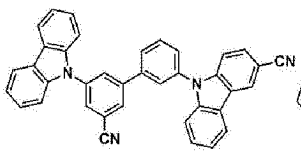

BH22

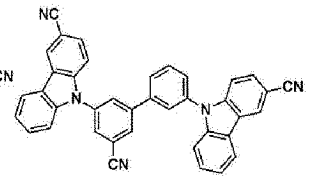

BH23


BH24


BH25


BH26

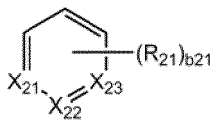

BH27


BH28

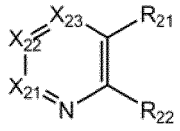
7. An organic light-emitting device (10) according to any one of claims 1 to 6, wherein M_{11} in Formulae 2A and 2B is selected from Pt, Pd, Cu, Ag, and Au.

8. An organic light-emitting device (10) according to any one of claims 1 to 7, wherein

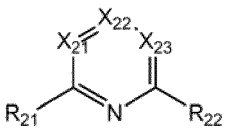
A_{12} and A_{13} in Formulae 2A and 2B are each independently represented by one selected from Formulae 2-1 to 2-43:



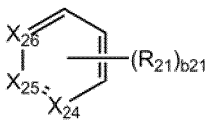
2-1



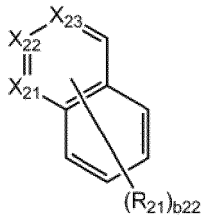
2-2



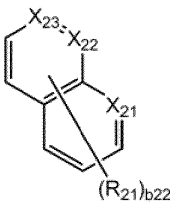
2-3



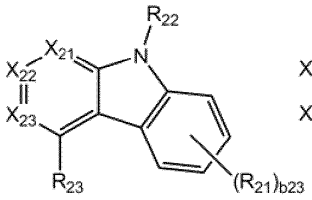
2-4



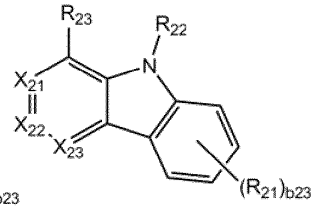
2-5



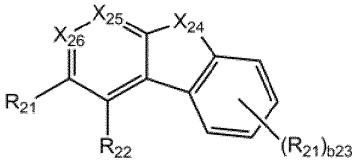
2-6



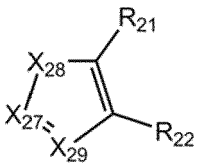
2-7



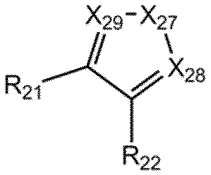
2-8



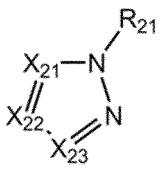
2-9



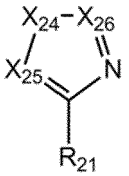
2-10



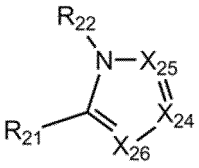
2-11



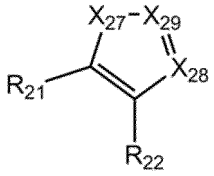
2-12



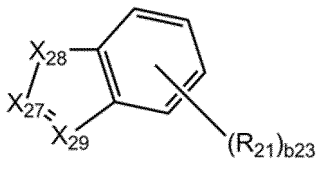
2-13



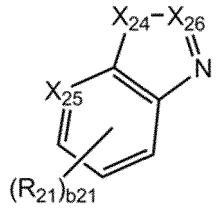
2-14



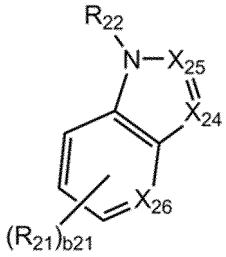
2-15



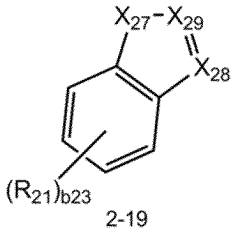
2-16



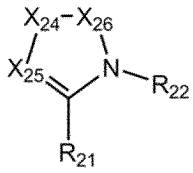
2-17



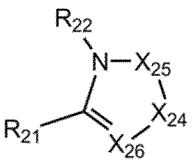
2-18



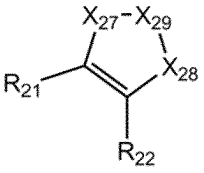
2-19



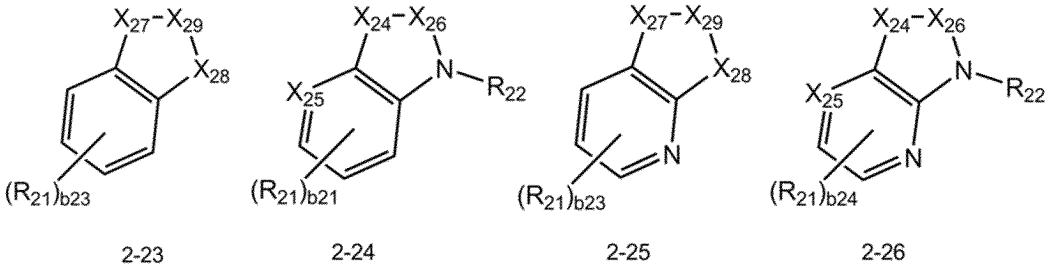
2-20



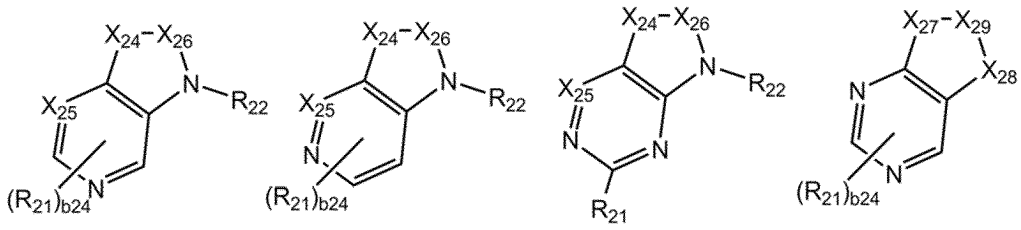
2-21



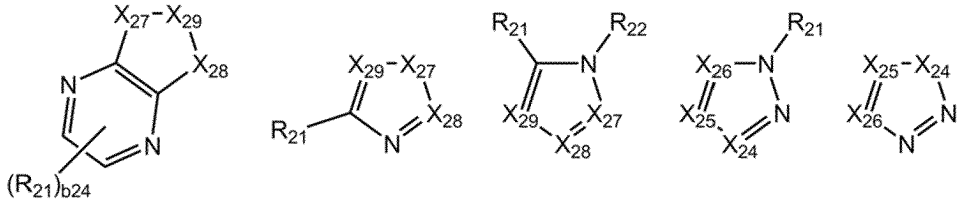
2-22



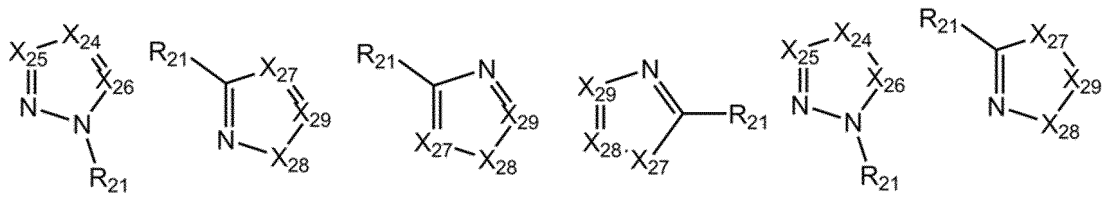
2-23 2-24 2-25 2-26



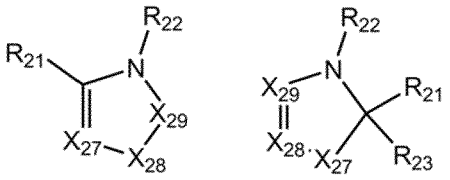
2-27 2-28 2-29 2-30



2-31 2-32 2-33 2-34 2-35



2-36 2-37 2-38 2-39 2-40 2-41



2-42 2-43

wherein, in Formulae 2-1 to 2-43,

X_{21} to X_{23} are each independently selected from $C(R_{24})$ and C-*, wherein at least two of X_{21} to X_{23} are each C-*,

X_{24} is N-*, and X_{25} and X_{26} are each independently selected from $C(R_{24})$ and C-*, wherein at least one of X_{25} and X_{26} is C-*,

X_{27} and X_{28} are each independently selected from N, $N(R_{25})$, and N-*, and X_{29} is selected from $C(R_{24})$ and C-*, wherein i) at least one of X_{27} and X_{28} is N-* and X_{29} is C-*, or ii) X_{27} and X_{28} are each N-* and X_{29} is $C(R_{24})$,

R_{21} to R_{25} are each independently the same as described in connection with R_{11} in Formula 1,

b21 is selected from 1, 2, and 3,

b22 is selected from 1, 2, 3, 4, and 5,

b23 is selected from 1, 2, 3, and 4,

b24 is selected from 1 and 2, and

* indicates a binding site to a neighboring atom.

9. An organic light-emitting device (10) according to any one of claims 1 to 8, wherein,

in Formulae 2A and 2B,
Y_{11}, Y_{12}, and Y_{13} are each C, and Y_{14} is N;
Y_{11}, Y_{12}, and Y_{14} are each C, and Y_{13} is N;
Y_{11}, Y_{13}, and Y_{14} are each C, and Y_{12} is N;
Y_{12}, Y_{13}, and Y_{14} are each C, and Y_{11} is N;
Y_{11} and Y_{14} are each C, and Y_{12} and Y_{13} are each N;
Y_{11} and Y_{14} are each N, and Y_{12} and Y_{13} are each C;
Y_{11} and Y_{12} are each C, and Y_{13} and Y_{14} are each N;
Y_{11} and Y_{12} are each N, and Y_{13} and Y_{14} are each C;
Y_{11} and Y_{13} are each C, and Y_{12} and Y_{14} are each N; or
Y_{11} and Y_{13} are each N, and Y_{12} and Y_{14} are each C.

10. An organic light-emitting device (10) according to any one of claims 1 to 9, wherein,

in Formulae 2A and 2B,
L_{14} and L_{15} are each independently selected from *-O-*', *-S-*', *-N(R_{19})-*', a C_2-C_{20} alkylene group, a C_2-C_{20} alkenylene group, and a C_2-C_{20} alkynylene group,
R_{19} is selected from:

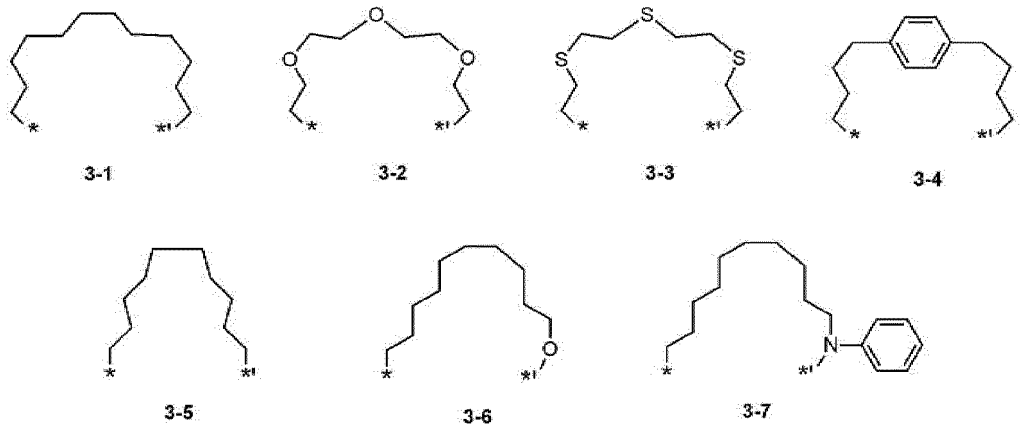
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and
a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, an azulenyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, and
L_{16} is selected from:

a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group; and
a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylene group, a pyrenylene group, a chrysenylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylene group, a quinazolinylene group, a carbazolylene group, and a triazinylene group, each substituted with at least one selected from deuterium, -F, -Cl, - Br, -I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1-C_{20} alkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a biphenyl group, a terphenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenan-

threnyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group.

11. An organic light-emitting device (10) according to any one of claims 1 to 10, wherein

a moiety represented by *-$(L_{14})_{b14}$-$(L_{16})_{b16}$-$(L_{15})_{b15}$-*' in Formulae 2A and 2B is represented by one selected from Formulae 3-1 to 3-7:

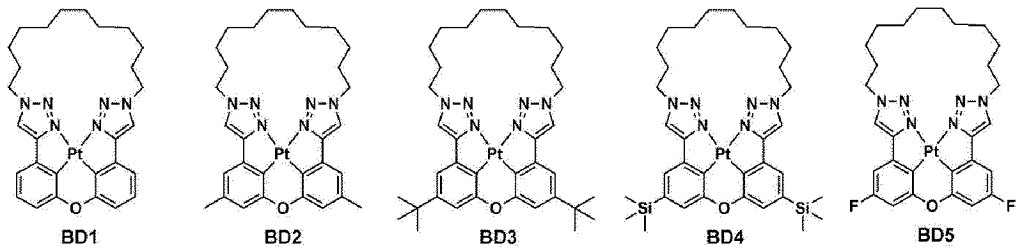


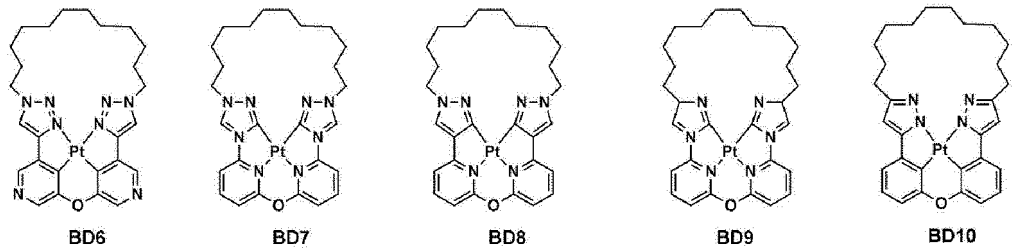
wherein, in Formulae 3-1 to 3-7,
* and *' each indicate a binding site to a neighboring atom.

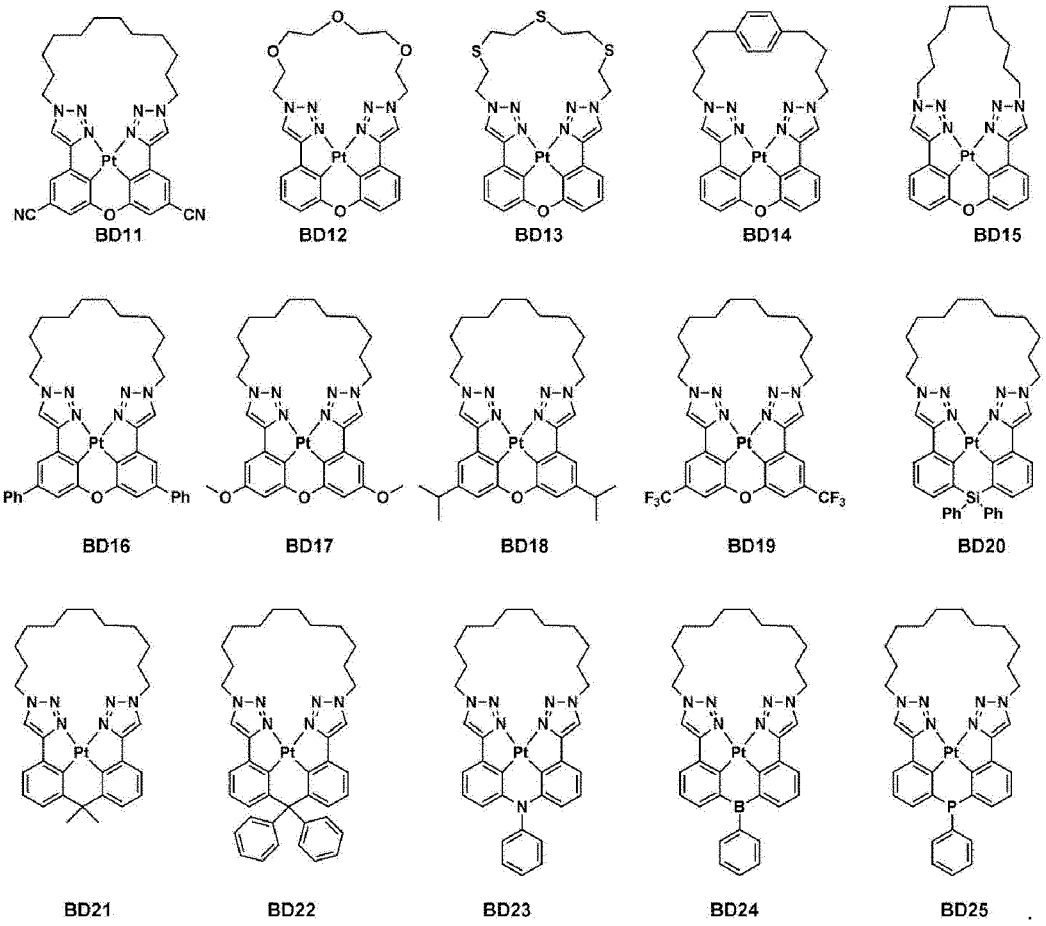
12. An organic light-emitting device (10) according to any one of claims 1 to 11, wherein
R_{11} to R_{19} in Formulae 2A and 2B are each independently selected from:

hydrogen, deuterium, -F, -Cl, -Br, -I, a cyano group, a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, and a tert-butyl group;
a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, and a tert-butyl group, each substituted with at least one selected from deuterium, -F, -Cl, -Br, -I, and a cyano group; and
a phenyl group, a naphthyl group, and a pyridinyl group.

13. An organic light-emitting device (10) according to any one of claims 1 to 12, wherein
the second compound is selected from Compounds BD1 to BD25, wherein Ph in Compounds BD1 to BD25 indicates a phenyl group:







14. An organic light-emitting device (10) according to any one of claims 1 to 13, wherein

the host further comprises a phosphine oxide-containing compound, and
the phosphine oxide-containing compound is different from the first compound.

15. An organic light-emitting device (10) according to any one of claims 1 to 14, wherein

the first electrode (110) is an anode,
the second electrode (190) is a cathode, and
the organic layer (150) further comprises a hole transport region between the first electrode (110) and the emission layer and an electron transport region between the emission layer and the second electrode (190),
the hole transport region comprises at least one selected from a hole injection layer, a hole transport layer, a buffer layer, an emission auxiliary layer, and an electron blocking layer, and
the electron transport region comprises at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer.

16. An organic light-emitting device (10) according to claim 15, wherein

the hole transport region comprises at least one of a hole injection layer and a hole transport layer, and
at least one of the hole injection layer and the hole transport layer comprises a p-dopant, or
the hole transport region comprises a single film comprising a p-dopant.

17. An organic light-emitting device (10) according to claim 15 or claim 16, wherein

the electron transport region comprises a hole blocking layer, and
the hole blocking layer comprises a phosphine oxide-containing compound or a silyl-containing compound.

18. A flat-panel display apparatus comprising:

a thin film transistor comprising a source electrode, a drain electrode, and an active layer; and
an organic light-emitting device (10) according to any one of claims 1 to 17,
wherein the first electrode (110) of the organic light-emitting device (10) is electrically connected to one of the source electrode and the drain electrode of the thin film transistor.

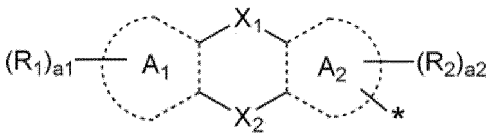
Patentansprüche

1. Organische lichtemittierende Vorrichtung (10), umfassend:

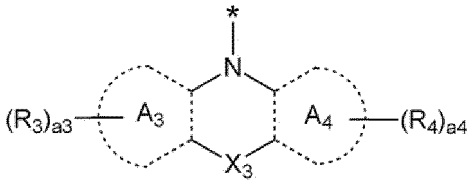
eine erste Elektrode (110);
eine zweite Elektrode (190) gegenüber der ersten Elektrode (110); und
eine organische Schicht (150) zwischen der ersten Elektrode (110) und der zweiten Elektrode (190), und umfassend eine Emissionsschicht,
wobei die Emissionsschicht einen Wirt und ein Dotierungsmittel umfasst, der Wirt eine durch die Formel 1 dargestellte erste Verbindung umfasst und das Dotierungsmittel eine durch die Formel 2A oder 2B dargestellte zweite Verbindung umfasst, und
die erste Verbindung nicht 1,3-Di-9-Carbazolylbenzol (mCP) ist:

Formel 1 $(CY_1)_{m1}$-$(L_1)_{b1}$-$(CY_2)_{m2}$

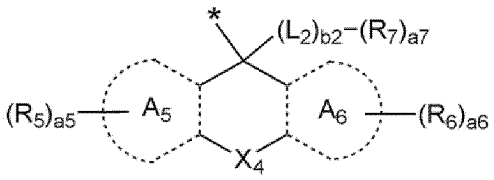
Formel 1-1



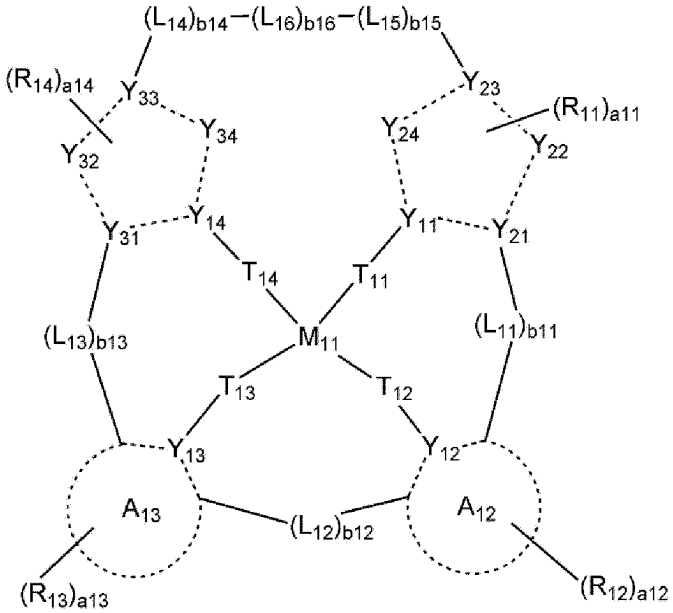
Formel 1-2



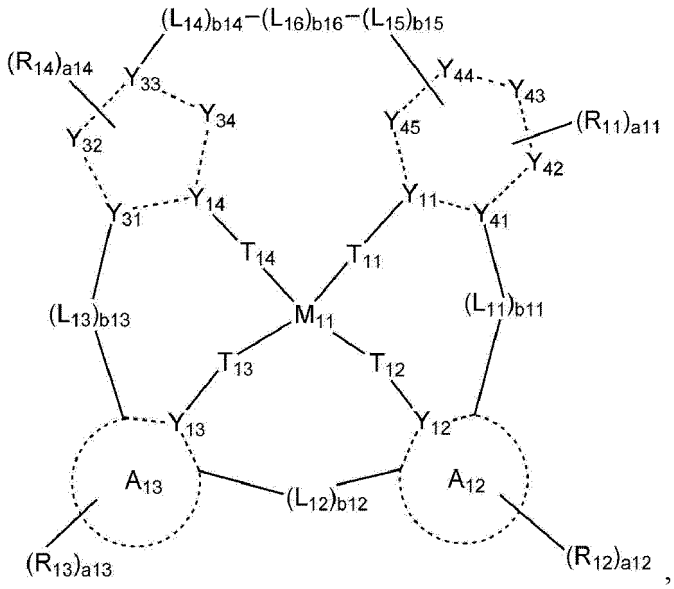
Formel 1-3



Formel 2A



Formel 2B



,

wobei in den Formeln 1, 1-1, 1-2, und 1-3

CY_1 und CY_2 jeweils unabhängig voneinander eine durch eine der Formeln 1-1, 1-2 und 1-3 dargestellte Gruppe sind,

m1 und m2 jeweils unabhängig voneinander 0, 1 oder 2 sind, wobei eine Summe von m1 und m2 2 ist,

L_1 und L_2 jeweils unabhängig voneinander ausgewählt sind aus einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkylengruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkylengruppe, einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkenylengruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkenylengruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Arylengruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Heteroarylengruppe, einer substituierten oder unsubstituierten zweiwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer substituierten oder unsubstituierten zweiwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe und $-Si(Q_1)(Q_2)-$,

b1 eine ganze Zahl von 0 bis 5 ist,

b2 eine ganze Zahl von 0 bis 4 ist,

X_1 bis X_4 jeweils unabhängig voneinander ausgewählt sind aus einer Einfachbindung, *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_8)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*', and *-Si(R_8)(R_9)-*',
die Ringe A_1 bis A_6 jeweils unabhängig voneinander eine C_5-C_{60}-carbozyklische Gruppe oder eine C_2-C_{60}-heterozyklische Gruppe sind,
R_1 bis R_9 jeweils unabhängig voneinander ausgewählt sind aus Wasserstoff, Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Aminogruppe, einer Amidinogruppe, einer Hydrazingruppe, einer Hydrazongruppe, einer Carbonsäuregruppe oder einem Salz davon, einer Sulfonsäuregruppe oder einem Salz davon, einer Phosphorsäuregruppe oder einem Salz davon, einer substituierten oder unsubstituierten C_1-C_{60}-Alkylgruppe, einer substituierten oder unsubstituierten C_2-C_{60}-Alkenylgruppe, einer substituierten oder unsubstituierten C_2-C_{60}-Alkinylgruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Alkoxygruppe, einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkylgruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkylgruppe, einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkenylgruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkenylgruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Arylgruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Aryloxygruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Arylthiogruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Heteroarylgruppe, einer substituierten oder unsubstituierten einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer substituierten oder unsubstituierten einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, -Si(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2), und -P(=S)(Q_1)(Q_2),
a1 bis a7 jeweils unabhängig voneinander eine ganze Zahl von 1 bis 8 sind,
in den Formeln 2A und 2B:

M_{11} ausgewählt ist aus Platin (Pt), Palladium (Pd), Kupfer (Cu), Silber (Ag), Gold (Au), Rhodium (Rh), Iridium (Ir), Ruthenium (Ru), Osmium (Os), Titan (Ti), Zirkonium (Zr), Hafnium (Hf), Europium (Eu), Terbium (Tb) und Thulium (Tm),
A_{12} und A_{13} jeweils unabhängig voneinander aus einer C_5-C_{60}-carbozyklischen Gruppe und einer C_1-C_{60}-heterozyklischen Gruppe ausgewählt sind,
Y_{11} bis Y_{14} jeweils unabhängig voneinander N oder C sind,
Y_{21} bis Y_{24} jeweils unabhängig voneinander N oder C sind,
Y_{31} bis Y_{34} jeweils unabhängig voneinander N oder C sind, und
Y_{41} bis Y_{45} jeweils unabhängig voneinander N oder C sind,
T_{11} bis T_{14} jeweils unabhängig voneinander aus einer Einfachbindung, O und S ausgewählt sind,
L_{11} bis L_{13} jeweils unabhängig voneinander ausgewählt sind aus einer Einfachbindung, *-O-*', *-S-*', *-C(R_{15})(R_{16})-*', *-C(R_{15})=*', *=C(R_{15})-*', *-C(R_{15})=C(R_{16})-*', *-C(=O)-*', *-C(=S)-*', *-C≡C-*', *-B(R_{15})-*', *-N(R_{15})-*', *-P(R_{15})-*', *-Si(R_{15})(R_{16})-*', *-P(=O)(R_{15})(R_{16})-*', und *-Ge(R_{15})(R_{16})-*',
b11 bis b13 jeweils unabhängig voneinander eine ganze Zahl von 0 bis 3 sind,
wenn b11 0 ist, Y_{21} oder Y_{41} nicht mit A_{12} verbunden ist, wenn b12 0 ist, A_{12} und A_{13} nicht miteinander verbunden sind, und wenn b13 0 ist, A_{13} und Y_{31} nicht miteinander verbunden sind,
L_{14} bis L_{16} jeweils unabhängig voneinander ausgewählt sind aus *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{17})-*', *-N(R_{17})-*', * -P(R_{17})-*', *-Si(R_{17})(R_{18})-*', *-P(=O)(R_{17})(R_{18})-*', *-Ge(R_{17})(R_{18})-*', einer zweiwertigen C_2-C_{20} Kohlenwasserstoffgruppe, einer zweiwertigen C_5-C_{60} carbozyklischen Gruppe und einer zweiwertigen C_1-C_{60}-heterozyklischen Gruppe,
b14 und b15 jeweils unabhängig voneinander eine ganze Zahl von 1 bis 5 sind,
b16 eine ganze Zahl von 0 bis 5 ist,
wenn b16 0 ist, L_{16} eine Einfachbindung ist,
R_{11} bis R_{18} jeweils unabhängig voneinander ausgewählt sind aus Wasserstoff, Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Amidinogruppe, einer Hydrazinogruppe, einer Hydrazonogruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Alkylgruppe, einer substituierten oder unsubstituierten C_2-C_{60}-Alkenylgruppe, einer substituierten oder unsubstituierten C_2-C_{60}-Alkinylgruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Alkoxygruppe, einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkylgruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkylgruppe, einer substituierten oder unsubstituierten C_3-C_{10}-Cycloalkenylgruppe, einer substituierten oder unsubstituierten C_1-C_{10}-Heterocycloalkenylgruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Arylgruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Aryloxygruppe, einer substituierten oder unsubstituierten C_6-C_{60}-Arylthiogruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Heteroarylgruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Heteroaryloxygruppe, einer substituierten oder unsubstituierten C_1-C_{60}-Heteroarylthiogruppe, einer substituierten oder unsubstituierten einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer substituierten oder unsubstituierten einwertigen

nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, -Si(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2) und -P(=S)(Q_1)(Q_2),
R_{15} und R_{11}; R_{15} und R_{12}; R_{15} und R_{13}; oder R_{15} und R_{14} optional verbunden sind, um eine substituierte oder unsubstituierte C_5-C_{60}-carbozyklische Gruppe oder eine substituierte oder unsubstituierte C_1-C_{60}-heterozyklische Gruppe zu bilden,
a11 bis a14 jeweils unabhängig voneinander eine ganze Zahl von 1 bis 8 sind,
* und *' jeweils eine Bindungsstelle zu einem benachbarten Atom angeben,
mindestens ein Substituent der substituierten C_3-C_{10}-Cycloalkylengruppe, der substituierten C_1-C_{10}-Heterocycloalkylengruppe, der substituierten C_3-C_{10}-Cycloalkenylengruppe, der substituierten C_1-C_{10}-Heterocycloalkenylengruppe, der substituierten C_6-C_{60}-Arylengruppe, der substituierten C_1-C_{60}-Heteroarylengruppe, der substituierten zweiwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, der substituierten zweiwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, der substituierten C_1-C_{60}-Alkylgruppe, der substituierten C_2-C_{60}-Alkenylgruppe, der substituierten C_2-C_{60}-Alkinylgruppe, der substituierten C_1-C_{60}-Alkoxygruppe, der substituierten C_3-C_{10}-Cycloalkylgruppe, der substituierten C_1-C_{10}-Heterocycloalkylgruppe, der substituierten C_3-C_{10}-Cycloalkenylgruppe, der substituierten C_1-C_{10}-Heterocycloalkenylgruppe, der substituierten C_6-C_{60}-Arylgruppe, der substituierten C_6-C_{60}-Aryloxygruppe, der substituierten C_6-C_{60}-Arylthiogruppe, der substituierten C_1-C_{60}-Heteroarylgruppe, der substituierten einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe und der substituierten einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe ausgewählt ist aus:

Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Amidinogruppe, einer Hydrazinogruppe, einer Hydrazonogruppe, einer C_1-C_{60}-Alkylgruppe, einer C_2-C_{60}-Alkenylgruppe, einer C_2-C_{60}-Alkinylgruppe und einer C_1-C_{60}-Alkoxygruppe;
einer C_1-C_{60}-Alkylgruppe, einer C_2-C_{60}-Alkenylgruppe, einer C_2-C_{60}-Alkinylgruppe und einer C_1-C_{60}-Alkoxygruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Amidinogruppe, einer Hydrazinogruppe und einer Hydrazonogruppe, einer C_3-C_{10}-Cycloalkylgruppe, einer C_1-C_{10}-Heterocycloalkylgruppe, einer C_3-C_{10}-Cycloalkenylgruppe, einer C_1-C_{10}-Heterocycloalkenylgruppe, einer C_6-C_{60}-Arylgruppe, einer C_6-C_{60}-Aryloxygruppe, einer C_6-C_{60}-Arylthiogruppe, einer C_1-C_{60}-Heteroarylgruppe, einer einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, -Si(Q_{11})(Q_{12})(Q_{13}), -N(Q_{11})(Q_{12}), -B(Q_{11})(Q_{12}), -C(=O)(Q_{11}), -S(=O)$_2$(Q_{11}), und -P(=O)(Q_{11})(Q_{12});
einer C_3-C_{10}-Cycloalkylgruppe, einer C_1-C_{10}-Heterocycloalkylgruppe, einer C_3-C_{10}-Cycloalkenylgruppe, einer C_1-C_1-Heterocycloalkenylgruppe, einer C_6-C_{60}-Arylgruppe, einer C_6-C_{60}-Aryloxygruppe, einer C_6-C_{60}-Arylthiogruppe, einer C_1-C_{60}-Heteroarylgruppe, einer einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, einer Biphenylgruppe und einer Terphenylgruppe;
einer C_3-C_{10}-Cycloalkylgruppe, einer C_1-C_{10}-Heterocycloalkylgruppe, einer C_3-C_{10}-Cycloalkenylgruppe, einer C_1-C_{10}-Heterocycloalkenylgruppe, einer C_6-C_{60}-Arylgruppe, einer C_6-C_{60}-Aryloxygruppe, einer C_6-C_{60}-Arylthiogruppe, einer C_1-C_{60}-Heteroarylgruppe, einer einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe und einer einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Amidinogruppe, einer Hydrazinogruppe, einer Hydrazonogruppe, einer C_1-C_{60}-Alkylgruppe, einer C_2-C_{60}-Alkenylgruppe, einer C_2-C_{60}-Alkinylgruppe, einer C_1-C_{60}-Alkoxygruppe, einer C_3-C_{10}-Cycloalkylgruppe, einer C_1-C_{10}-Heterocycloalkylgruppe, einer C_3-C_{10}-Cycloalkenylgruppe, einer C_1-C_{10}-Heterocycloalkenylgruppe, einer C_6-C_{60}-Arylgruppe, einer C_6-C_{60}-Aryloxygruppe, einer C_6-C_{60}-Arylthiogruppe, einer C_1-C_{60}-Heteroarylgruppe, einer einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe, einer einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe, ausgenommen eine Carbazolylgruppe, -Si(Q_{21})(Q_{22})(Q_{23}), -N(Q_{21})(Q_{22}), -B(Q_{21})(Q_{22}), -C(=O)(Q_{21}), -S(=O)$_2$(Q_{21}), and -P(=O)(Q_{21})(Q_{22}); und
-Si(Q_{31})(Q_{32})(Q_{33}), -N(Q_{31})(Q_{32}), -B(Q_{31})(Q_{32}), -C(=O)(Q_{31}), -S(=O)$_2$(Q_{31}) und -P(=O)(Q_{31})(Q_{32}), und
Q_1 bis Q_3, Q_{11} bis Q_{13}, Q_{21} bis Q_{23} und Q_{31} bis Q_{33} jeweils unabhängig voneinander aus Wasserstoff, Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Amidinogruppe, einer Hydrazinogruppe, einer Hydrazonogruppe, einer C_1-C_{60}-Alkylgruppe, einer C_2-C_{60}-Alkenylgruppe, einer C_2-C_{60}-Alkinylgruppe, einer C_1-C_{60}-Alkoxygruppe, einer C_3-C_{10}-Cycloalkylgruppe, einer C_1-C_{10}-Heterocycloalkylgruppe, einer C_3-C_{10}-Cycloalkenylgruppe, einer C_1-C_{10}-Heterocycloalkenylgruppe, einer C_6-C_{60}-Arylgruppe, einer mit einer C_1-C_{60}-Alkylgruppe substituierten C_6-C_{60}-Aryl-

gruppe, einer mit einer C_6-C_{60}-Arylgruppe substituierten C_6-C_{60}-Arylgruppe, einer Terphenylgruppe, einer C_1-C_{60}-Heteroarylgruppe, einer mit einer C_1-C_{60}-Alkylgruppe substituierten C_1-C_{60}-Heteroarylgruppe, einer mit einer C_6-C_{60}-Arylgruppe substituierten C_1-C_{60}-Heteroarylgruppe, einer einwertigen nicht-aromatischen kondensierten polyzyklischen Gruppe und einer einwertigen nicht-aromatischen kondensierten heteropolyzyklischen Gruppe ausgewählt sind.

2. Organische lichtemittierende Vorrichtung (10) nach Anspruch 1, wobei
L_1 und L_2 in den Formeln 1, 1-1, 1-2 und 1-3 jeweils unabhängig voneinander ausgewählt sind aus:

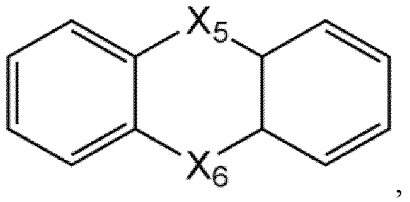
einer Phenylengruppe, einer Naphthylengruppe, einer Fluorenylengruppe, einer Spirofluorenylengruppe, einer Benzofluorengruppe, einer Dibenzofluorengruppe, einer Phenanthrenylengruppe, einer Anthracenylengruppe, einer Pyrenylengruppe, einer Chrysenylengruppe, einer Pyridinylengruppe, einer Pyrazinylengruppe, einer Pyrimidinylengruppe, einer Pyridazinylengruppe, einer Chinolinylengruppe, einer Isochinolinylengruppe, einer Chinoxalinylengruppe, einer Chinazolinylengruppe, einer Carbazolylengruppe und einer Triazinylengruppe;
einer Phenylengruppe, einer Naphthylengruppe, einer Fluorenylengruppe, einer Spirofluorenylengruppe, einer Benzofluorenylengruppe, einer Dibenzofluorenylengruppe, einer Phenanthrenylengruppe, einer Anthracenylengruppe, einer Pyrenylengruppe, einer Chrysenylengruppe, einer Pyridinylengruppe, einer Pyrazinylengruppe, einer Pyrimidinylengruppe, einer Pyridazinylengruppe, einer Chinolinylengruppe, einer Isochinolinylengruppe, einer Chinoxalinylengruppe, einer Chinazolinylengruppe, einer Carbazolylengruppe und einer Triazinylengruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Aminogruppe, einer Amidinogruppe, einer Hydrazingruppe, einer Hydrazongruppe, einer Carbonsäuregruppe oder einem Salz davon, einer Sulfonsäuregruppe oder einem Salz davon, einer Phosphorsäuregruppe oder einem Salz davon, einer C_1-C_{20}-Alkylgruppe, einer C_1-C_{20}-Alkoxygruppe, einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Spirofluorenylgruppe, einer Benzofluorenylgruppe, einer Dibenzofluorenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Pyrenylgruppe, einer Chrysenylgruppe, einer Pyridinylgruppe, einer Pyrazinylgruppe, einer Pyrimidinylgruppe, einer Pyridazinylgruppe, einer Isoindolylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe und einer Triazinylgruppe; und
$-Si(Q_4)(Q_5)-$, und
wobei Q_4 und Q_5 jeweils unabhängig voneinander ausgewählt sind aus:

einer C_1-C_{10}-Alkylgruppe, einer C_1-C_{10}-Alkoxygruppe und einer Phenylgruppe; und
einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe und einer Naphthylgruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten. Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer C_1-C_{20}-Alkylgruppe, einer C_1-C_{20}-Alkoxygruppe, einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe und einer Naphthylgruppe.

3. Organische lichtemittierende Vorrichtung (10) nach Anspruch 1 oder Anspruch 2, wobei

A_1 bis A_6 in den Formeln 1-1, 1-2 und 1-3 jeweils unabhängig voneinander ausgewählt sind aus einem Benzolring, einem Naphthalinring, einem Pyridinring, einem Pyrimidinring, einem Pyrazinring, einem Pyridazinring, einem Triazinring, einem Chinolinring, einem Isochinolinring, einem Chinoxalinring, einem Chinazolinring und einem durch die Formel 4 dargestellten Ring:

Formel 4



,

wobei in Formel 4:

X_5 und X_6 jeweils unabhängig voneinander ausgewählt sind aus *-O-*, *-S-*, $*-C(R_8)(R_9)-*'$, *-C(=O)-*', $*-B(R_8)(R_9)-*'$, $*-N(R_8)-*'$, $*-P(R_8)-*'$ und $*-Si(R_8)(R_9)-*'$, und

R_8 und R_9 die gleichen sind wie im Zusammenhang mit den Formeln 1, 1-1, 1-2 und 1-3 beschrieben.

4. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 3, wobei
R_1 bis R_9 in den Formeln 1-1, 1-2 und 1-3 jeweils unabhängig voneinander ausgewählt sind aus:

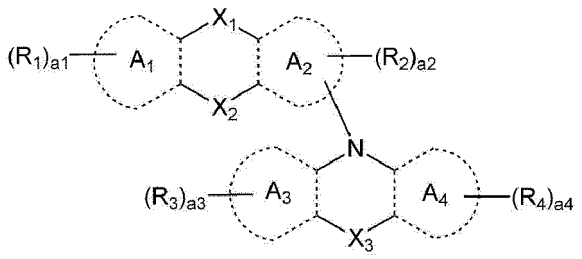
Wasserstoff, Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Aminogruppe, einer Amidinogruppe, einer Hydrazingruppe, einer Hydrazongruppe, einer Carbonsäuregruppe oder einem Salz davon, einer Sulfonsäuregruppe oder einem Salz davon, einer Phosphorsäuregruppe oder einem Salz davon, einer C_1-C_{60}-Alkylgruppe, einer C_2-C_{60}-Alkenylgruppe, einer C_2-C_{60}-Alkinylgruppe, einer C_1-C_{60}-Alkoxygruppe, einer Phenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Pyrenylgruppe, einer Phenalenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Fluoranthenylgruppe, einer Triphenylenylgruppe, einer Pyrazolylgruppe, einer Imidazolylgruppe, einer Benzimidazolylgruppe, einer Pyridinylgruppe, einer Pyrimidylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Benzochinolinylgruppe, einer Naphthyridinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe, einer Phenanthridinylgruppe, einer Acridinylgruppe, einer Phenanthrolinylgruppe, einer Phenazinylgruppe, einer Triazinylgruppe, einer Dibenzofuranylgruppe, einer Dibenzothiophenylgruppe, einer Biphenylgruppe und einer Terphenylgruppe;
einer Phenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Pyrenylgruppe, einer Phenalenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Fluoranthenylgruppe, einer Triphenylenylgruppe, einer Pyrazolylgruppe, einer Imidazolylgruppe, einer Benzimidazolylgruppe, einer Pyridinylgruppe, einer Pyrimidylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Benzochinolinylgruppe, einer Naphthyridinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe, einer Phenanthridinylgruppe, einer Acridinylgruppe, einer Phenanthrolinylgruppe, einer Phenazinylgruppe, einer Triazinylgruppe, einer Dibenzofuranylgruppe, einer Dibenzothiophenylgruppe, einer Biphenylgruppe und einer Terphenylgruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Methylgruppe, einer Ethylgruppe, einer Propylgruppe, einer Isobutylgruppe, einer sec-Butylgruppe, einer ter-Butylgruppe, einer Pentylgruppe, einer Isoamylgruppe, einer Hexylgruppe, einer C_1-C_{60}-Alkoxygruppe, einer Cyclopentylgruppe, einer Cyclohexylgruppe, einer Cycloheptylgruppe, einer Cyclopentenylgruppe, einer Cyclohexenylgruppe, einer Phenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Pyrenylgruppe, einer Phenalenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Fluoranthenylgruppe, einer Triphenylenylgruppe, einer Pyrazolylgruppe, einer Imidazolylgruppe, einer Benzimidazolylgruppe, einer Pyridinylgruppe, einer Pyrimidylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Benzochinolinylgruppe, einer Naphthyridinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe, einer Phenanthridinylgruppe, einer Acridinylgruppe, einer Phenanthrolinylgruppe, einer Phenazinylgruppe, einer Triazinylgruppe, einer Dibenzofuranylgruppe, einer Dibenzothiophenylgruppe, einer Biphenylgruppe und einer Terphenylgruppe; und
$-Si(Q_4)(Q_5)(Q_6)$ und $-P(=O)(Q_4)(Q_5)$, und
wobei Q_4 bis Q_6 jeweils unabhängig voneinander ausgewählt sind aus:

einer C_1-C_{10}-Alkylgruppe, einer C_1-C_{10}-Alkoxygruppe und einer Phenylgruppe; und
einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe und einer Naphthylgruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer C_1-C_{20}-Alkylgruppe, einer C_1-C_{20}-Alkoxygruppe, einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe und einer Naphthylgruppe.

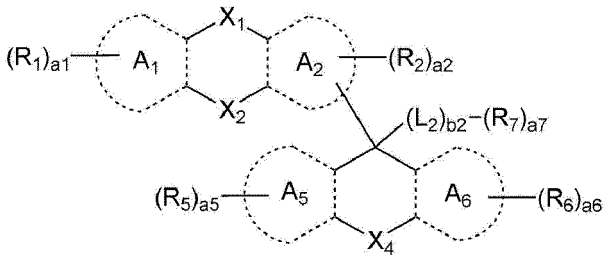
5. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 4, wobei

die erste Verbindung eine Verbindung ist, die durch eine der Formeln 1A, 1B und 1C dargestellt wird:

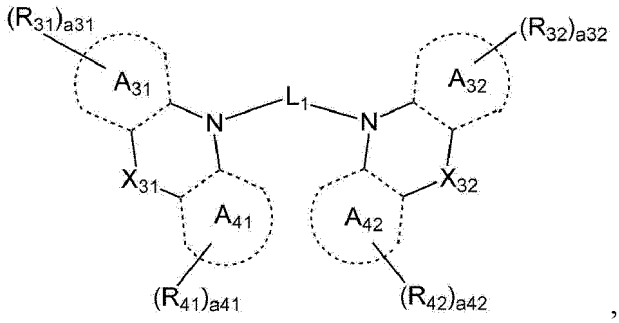
Formel 1A



Formel 1B



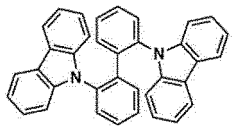
Formel 1C



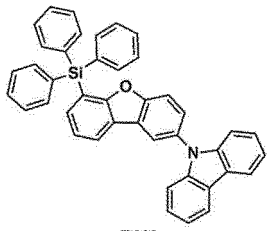
,

wobei in den Formeln 1A, 1B und 1C
X_1 bis X_4, A_1 bis A_6, L_1, L_2, b2, R_1 bis R_7 und a1 bis a7 die gleichen sind wie im Zusammenhang mit den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
X_{31} und X_{32} sind jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit X_3 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
A_{31} und A_{32} jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit A_3 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
A_{41} und A_{42} jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit A_4 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
R_{31} und R_{32} jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit R_3 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
R_{41} und R_{42} jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit R_4 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben,
a31 und a32 jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit a3 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben, und
a41 und a42 jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit a4 in den Formeln 1, 1-1, 1-2, und 1-3 beschrieben.

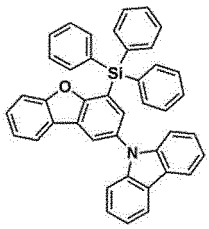
6. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 5, wobei die erste Verbindung ausgewählt ist aus den Verbindungen BH2 bis BH28:



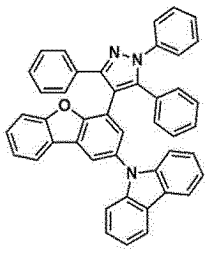
BH2



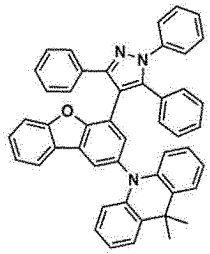
BH3



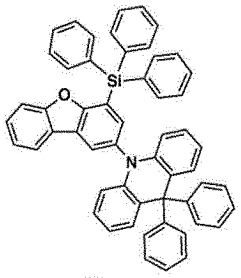
BH4



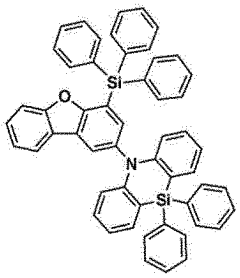
BH5



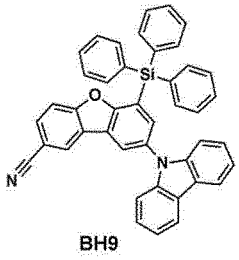
BH6



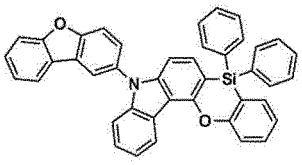
BH7



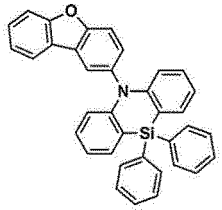
BH8



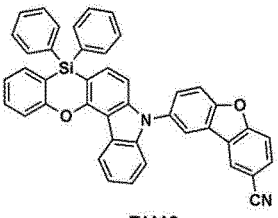
BH9



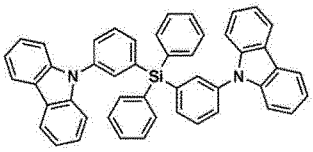
BH10



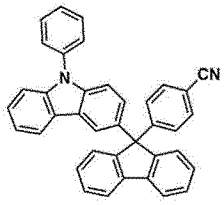
BH11



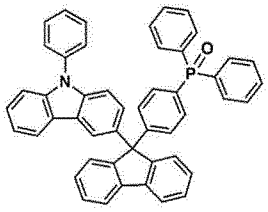
BH12



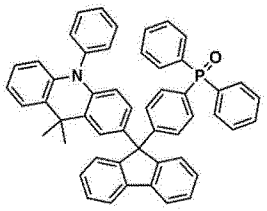
BH13



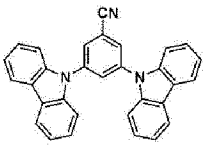
BH14



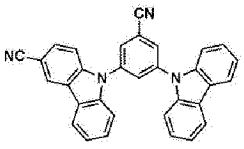
BH15



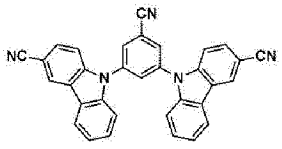
BH16



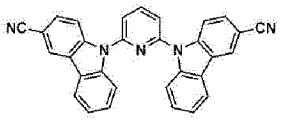
BH17



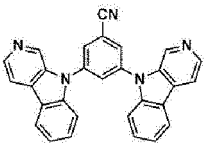
BH18



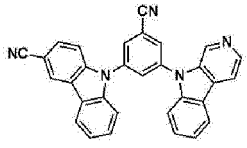
BH19



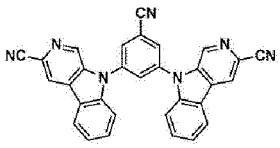
BH20



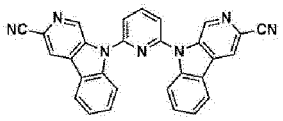
BH21



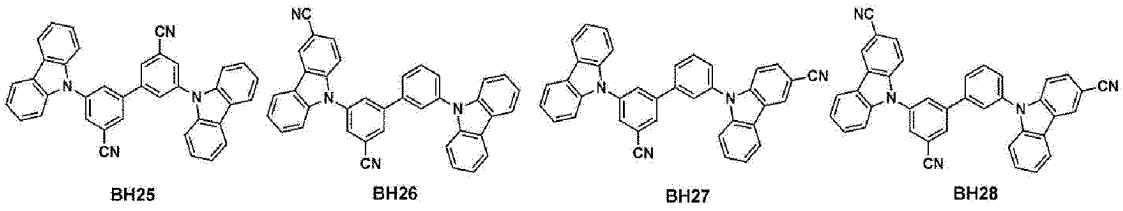
BH22



BH23



BH24

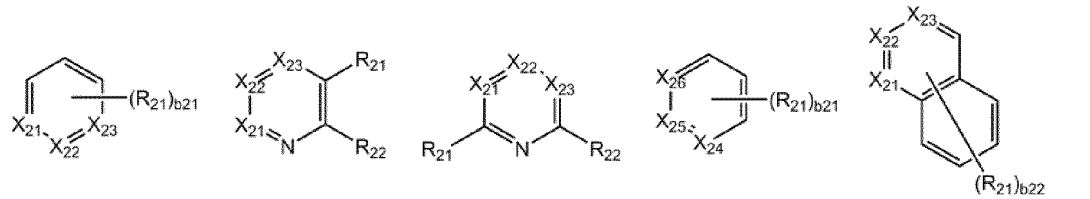


BH25 BH26 BH27 BH28

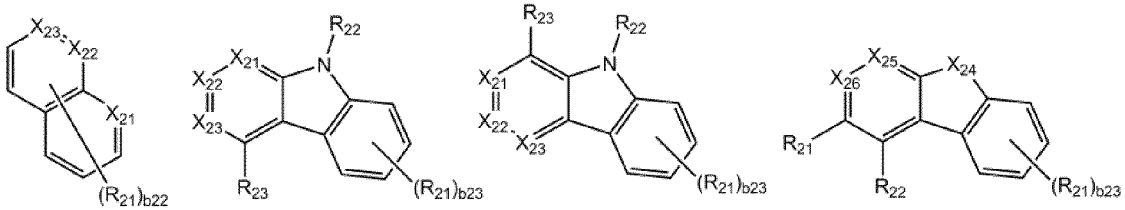
7. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 6, wobei M_{11} in den Formeln 2A und 2B ausgewählt ist aus Pt, Pd, Cu, Ag und Au.

8. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 7, wobei

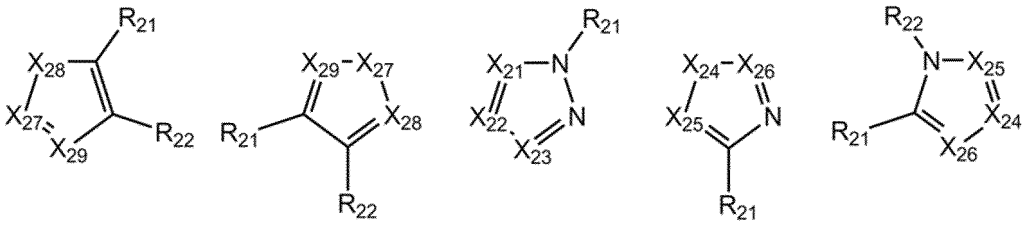
A_{12} und A_{13} in den Formeln 2A und 2B jeweils unabhängig voneinander durch eine aus den Formeln 2-1 bis 2-43 ausgewählte Verbindung dargestellt sind:



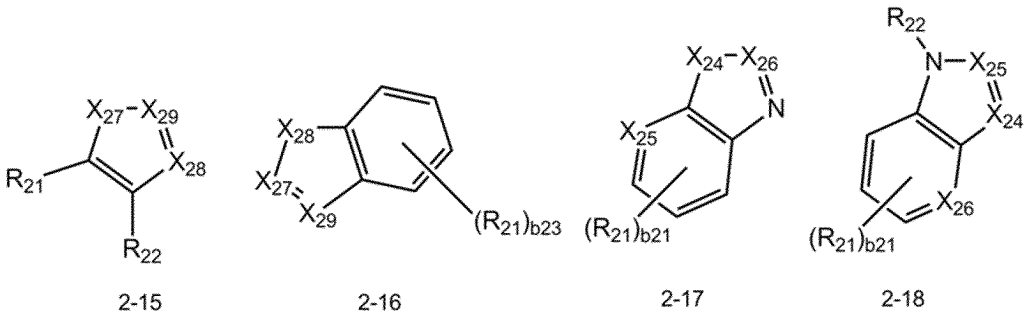
2-1 2-2 2-3 2-4 2-5



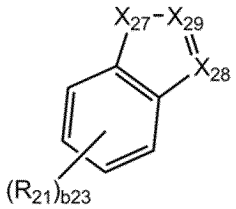
2-6 2-7 2-8 2-9

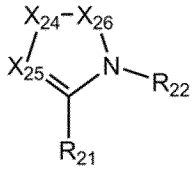


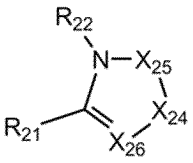
2-10 2-11 2-12 2-13 2-14

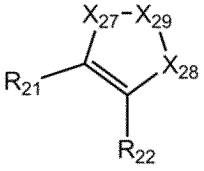


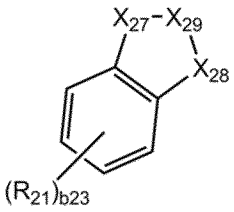
2-15 2-16 2-17 2-18

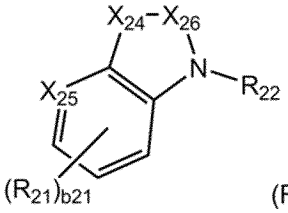

2-19

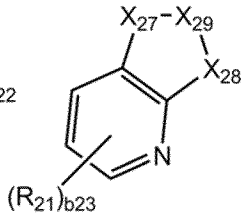

2-20

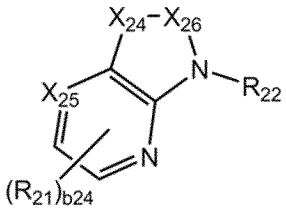

2-21

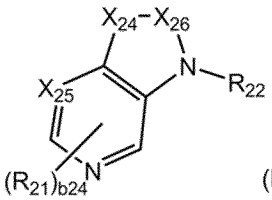

2-22

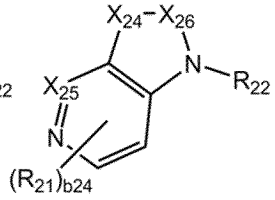

2-23

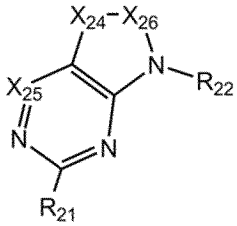

2-24

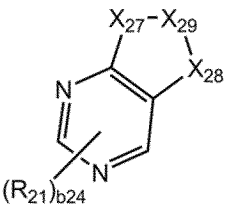

2-25

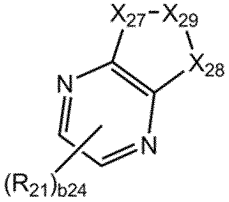

2-26

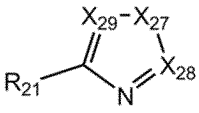

2-27

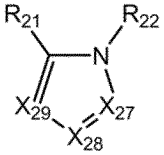

2-28

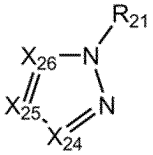

2-29

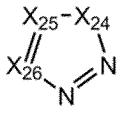

2-30

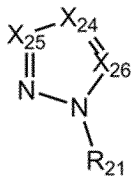

2-31

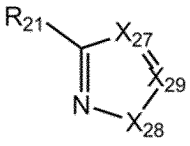

2-32

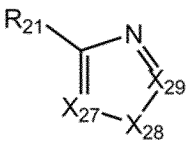

2-33

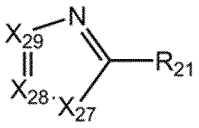

2-34

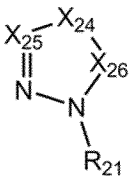

2-35

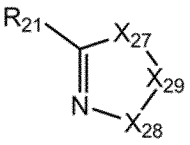

2-36

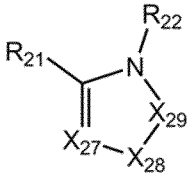

2-37

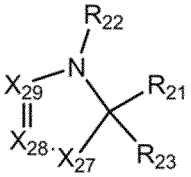

2-38


2-39


2-40


2-41


2-42


2-43

,

wobei in den Formeln 2-1 bis 2-43

X_{21} bis X_{23} jeweils unabhängig voneinander aus $C(R_{24})$ und C-* ausgewählt sind, wobei mindestens zwei von X_{21} bis X_{23} jeweils C-* sind,
X_{24} N-* ist und X_{25} und X_{26} jeweils unabhängig voneinander ausgewählt sind aus $C(R_{24})$ und C-*, wobei mindestens eines von X_{25} und X_{26} C-* ist,
X_{27} und X_{28} jeweils unabhängig voneinander aus N, $N(R_{25})$ und N-* ausgewählt sind und X_{29} aus $C(R_{24})$ und C-* ausgewählt ist, wobei i) mindestens eines von X_{27} und X_{28} N-* ist und X_{29} C-* ist, oder ii) X_{27} und X_{28} jeweils N-* sind und X_{29} $C(R_{24})$ ist,
R_{21} bis R_{25} jeweils unabhängig voneinander die gleichen sind wie im Zusammenhang mit R_{11} in Formel 1 beschrieben,
b21 ausgewählt ist aus 1, 2 und 3,
b22 ausgewählt ist aus 1, 2, 3, 4 und 5,
b23 ausgewählt ist aus 1, 2, 3 und 4,
b24 ausgewählt ist aus 1 und 2, und
* eine Bindungsstelle zu einem benachbarten Atom angibt.

9. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 8, wobei in den Formeln 2A und 2B:

Y_{11}, Y_{12} und Y_{13} jeweils C sind und Y_{14} N ist;
Y_{11}, Y_{12} und Y_{14} jeweils C sind und Y_{13} N ist;
Y_{11}, Y_{13} und Y_{14} jeweils C sind und Y_{12} N ist;
Y_{12}, Y_{13} und Y_{14} jeweils C sind und Y_{11} N ist;
Y_{11} und Y_{14} jeweils C sind und Y_{12} und Y_{13} jeweils N sind;
Y_{11} und Y_{14} jeweils N sind und Y_{12} und Y_{13} jeweils C sind;
Y_{11} und Y_{12} jeweils C sind und Y_{13} und Y_{14} jeweils N sind;
Y_{11} und Y_{12} jeweils N sind und Y_{13} und Y_{14} jeweils C sind;
Y_{11} und Y_{13} jeweils C sind und Y_{12} und Y_{14} jeweils N sind; oder
Y_{11} und Y_{13} jeweils N sind und Y_{12} und Y_{14} jeweils C sind.

10. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 9, wobei

in den Formeln 2A und 2B
L_{14} und L_{15} jeweils unabhängig voneinander ausgewählt sind aus *-O-*', *-S-*', *-$N(R_{19})$-*', einer C_2-C_{20}-Alkylengruppe, einer C_2-C_{20}-Alkenylengruppe und einer C_2-C_{20}-Alkinylengruppe,
R_{19} ausgewählt ist aus:

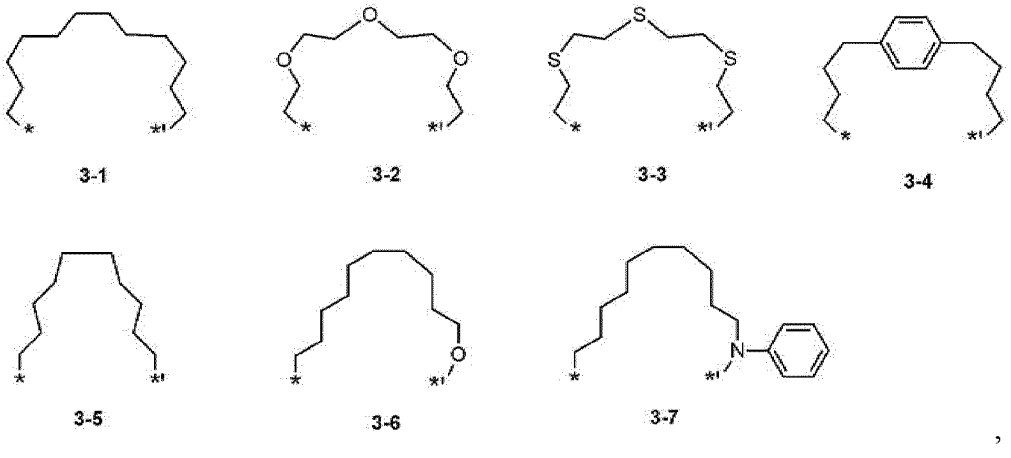
einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Spirofluorenylgruppe, einer Benzofluorenylgruppe, einer Dibenzofluorenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Pyrenylgruppe, einer Chrysenylgruppe, einer Pyridinylgruppe, einer Pyrazinylgruppe, einer Pyrimidinylgruppe, einer Pyridazinylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe und einer Triazinylgruppe; und
einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Spirofluorenylgruppe, einer Benzofluorenylgruppe, einer Dibenzofluorenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Pyrenylgruppe, einer Chrysenylgruppe, einer Pyridinylgruppe, einer Pyrazinylgruppe, einer Pyrimidinylgruppe, einer Pyridazinylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe und einer Triazinylgruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Aminogruppe, einer Amidinogruppe, einer Hydrazingruppe, einer Hydrazongruppe, einer Carbonsäuregruppe oder einem Salz davon, einer Sulfonsäuregruppe oder einem Salz davon, einer Phosphorsäuregruppe oder einem Salz davon, einer C_1-C_{20}-Alkylgruppe, einer C_1-C_{20}-Alkoxygruppe, einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe, einer Naphthylgruppe, einer Azulenylgruppe, einer Fluorenylgruppe, einer Spirofluorenylgruppe, einer Benzofluorenylgruppe, einer Dibenzofluorenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Pyrenylgruppe, einer Chrysenylgruppe, einer Pyridinylgruppe, einer Pyrazinylgruppe, einer Pyrimidinylgruppe, einer Pyridazinylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe, und einer Triazinylgruppe, und

L_{16} ausgewählt ist aus:

einer Phenylengruppe, einer Naphthylengruppe, einer Fluorenylengruppe, einer Spirofluorenylengruppe, einer Benzofluorengruppe, einer Dibenzofluorengruppe, einer Phenanthrenylengruppe, einer Anthracenylengruppe, einer Pyrenylengruppe, einer Chrysenylengruppe, einer Pyridinylengruppe, einer Pyrazinylengruppe, einer Pyrimidinylengruppe, einer Pyridazinylengruppe, einer Chinolinylengruppe, einer Isochinolinylengruppe, einer Chinoxalinylengruppe, einer Chinazolinylengruppe, einer Carbazolylengruppe und einer Triazinylengruppe; und
einer Phenylengruppe, einer Naphthylengruppe, einer Fluorenylengruppe, einer Spirofluorenylengruppe, einer Benzofluorenylengruppe, einer Dibenzofluorenylengruppe, einer Phenanthrenylengruppe, einer Anthracenylengruppe, einer Pyrenylengruppe, einer Chrysenylengruppe, einer Pyridinylengruppe, einer Pyrazinylengruppe, einer Pyrimidinylengruppe, einer Pyridazinylengruppe, einer Chinolinylengruppe, einer Isochinolinylengruppe, einer Chinoxalinylengruppe, einer Chinazolinylengruppe, einer Carbazolylengruppe und einer Triazinylengruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I, einer Hydroxylgruppe, einer Cyanogruppe, einer Nitrogruppe, einer Aminogruppe, einer Amidinogruppe, einer Hydrazingruppe und einer Hydrazongruppe, einer Carbonsäuregruppe oder einem Salz davon, einer Sulfonsäuregruppe oder einem Salz davon, einer Phosphorsäuregruppe oder einem Salz davon, einer C_1-C_{20}-Alkylgruppe, einer C_1-C_{20}-Alkoxygruppe, einer Phenylgruppe, einer Biphenylgruppe, einer Terphenylgruppe, einer Naphthylgruppe, einer Fluorenylgruppe, einer Spirofluorenylgruppe, einer Benzofluorenylgruppe, einer Dibenzofluorenylgruppe, einer Phenanthrenylgruppe, einer Anthracenylgruppe, einer Pyrenylgruppe, einer Chrysenylgruppe, einer Pyridinylgruppe, einer Pyrazinylgruppe, einer Pyrimidinylgruppe, einer Pyridazinylgruppe, einer Isoindolylgruppe, einer Chinolinylgruppe, einer Isochinolinylgruppe, einer Chinoxalinylgruppe, einer Chinazolinylgruppe, einer Carbazolylgruppe und einer Triazinylgruppe.

11. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 10, wobei

ein Anteil, der durch *-$(L_{14})_{b14}$-$(L_{16})_{b16}$-$(L_{15})_{b15}$-*' in den Formeln 2A und 2B dargestellt wird, durch eine aus den Formeln 3-1 bis 3-7 ausgewählte Formel dargestellt wird:



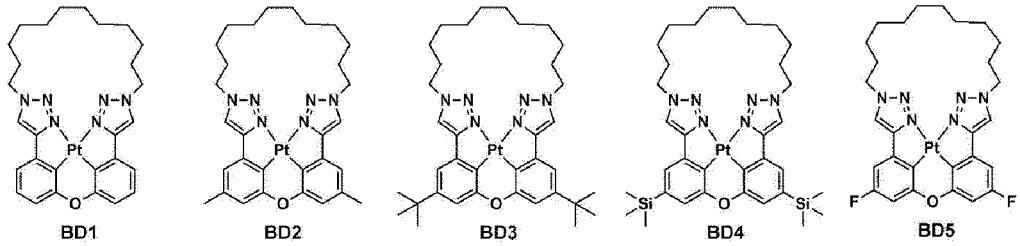
,

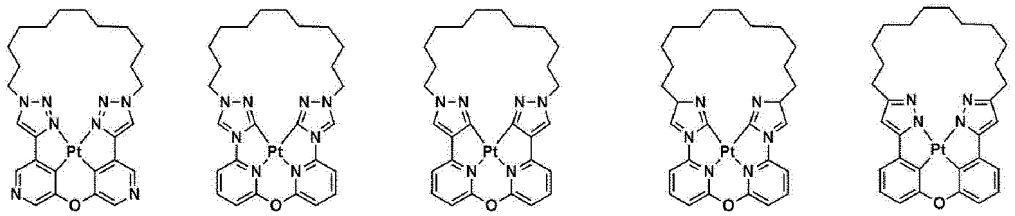
wobei in den Formeln 1-3 bis 3-7
* und *' jeweils eine Bindungsstelle zu einem benachbarten Atom angeben.

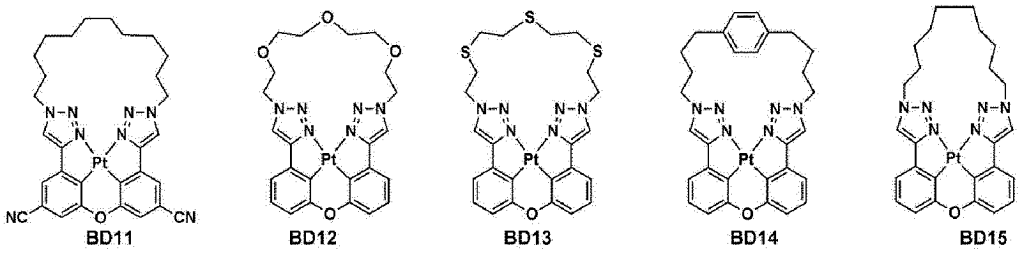
12. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 11, wobei
R_{11} bis R_{19} in den Formeln 2A und 2B jeweils unabhängig voneinander ausgewählt sind aus:

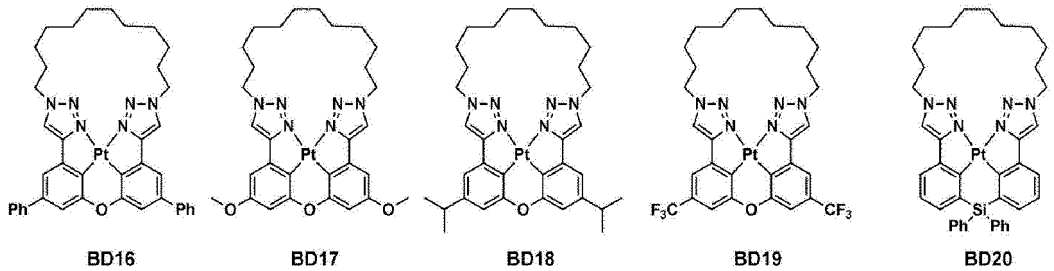
Wasserstoff, Deuterium, -F, -Cl, -Br, -I, einer Cyanogruppe, einer Methylgruppe, einer Ethylgruppe, einer n-Propylgruppe, einer Isopropylgruppe, einer n-Butylgruppe, einer Isobutylgruppe, einer sec-Butylgruppe und einer tert-Butylgruppe;
einer Methylgruppe, einer Ethylgruppe, einer n-Propylgruppe, einer Isopropylgruppe, einer n-Butylgruppe, einer Isobutylgruppe, einer sec-Butylgruppe und einer tert-Butylgruppe, jeweils substituiert mit mindestens einem aus den Folgenden ausgewählten: Deuterium, -F, -Cl, -Br, -I und einer Cyanogruppe; und
einer Phenylgruppe, einer Naphthylgruppe und einer Pyridinylgruppe.

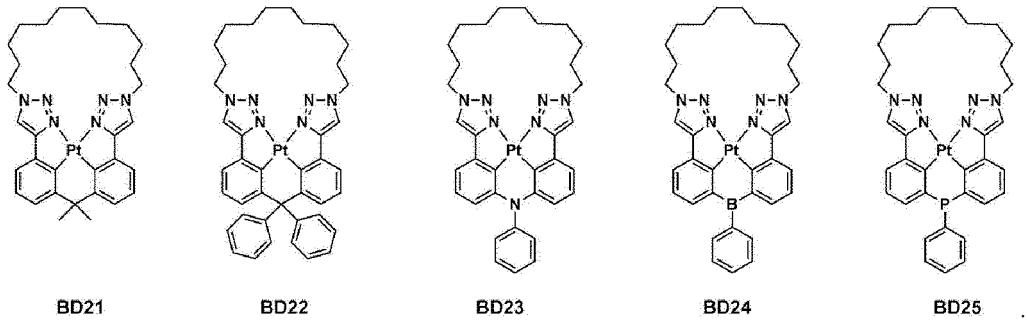
13. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 12, wobei die zweite Verbindung ausgewählt ist aus den Verbindungen BD1 bis BD25, wobei Ph in den Verbindungen BD1 bis BD25 eine Phenylgruppe angibt:


BD1 BD2 BD3 BD4 BD5


BD6 BD7 BD8 BD9 BD10


BD11 BD12 BD13 BD14 BD15


BD16 BD17 BD18 BD19 BD20


BD21 BD22 BD23 BD24 BD25

14. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 13, wobei

der Wirt ferner eine phosphinoxidhaltige Verbindung umfasst, und
die phosphinoxidhaltige Verbindung von der ersten Verbindung verschieden ist.

15. Organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 14, wobei

die erste Elektrode (110) eine Anode ist,
die zweite Elektrode (190) eine Kathode ist, und
die organische Schicht (150) ferner eine Lochtransportregion zwischen der ersten Elektrode (110) und der Emissionsschicht und eine Elektronentransportregion zwischen der Emissionsschicht und der zweiten Elektrode (190) umfasst,
die Lochtransportregion mindestens eine aus einer Lochinjektionsschicht, einer Lochtransportschicht, einer Pufferschicht, einer Emissionshilfsschicht und einer Elektronensperrschicht ausgewählte Schicht umfasst, und
die Elektronentransportregion mindestens eine aus einer Lochsperrschicht, einer Elektronentransportschicht und einer Elektroneninjektionsschicht ausgewählte Schicht umfasst.

16. Organische lichtemittierende Vorrichtung (10) nach Anspruch 15, wobei

die Lochtransportregion mindestens eine von einer Lochinjektionsschicht und einer Lochtransportschicht umfasst, und
mindestens eine von der Lochinjektionsschicht und der Lochtransportschicht ein p-Dotierungsmittel umfasst, oder
die Lochtransportregion einen einzelnen Film umfasst, der ein p-Dotierungsmittel umfasst.

17. Organische lichtemittierende Vorrichtung (10) nach Anspruch 15 oder Anspruch 16, wobei

die Elektronentransportregion eine Lochsperrschicht umfasst, und
die Lochsperrschicht eine phosphinoxidhaltige Verbindung oder eine silylhaltige Verbindung umfasst.

18. Anzeigeeinrichtung mit flacher Tafel, umfassend:

einen Dünnfilmtransistor, der eine Source-Elektrode, eine Drain-Elektrode und eine aktive Schicht umfasst; und eine organische lichtemittierende Vorrichtung (10) nach einem der Ansprüche 1 bis 17,
wobei die erste Elektrode (110) der organischen lichtemittierenden Vorrichtung (10) elektrisch mit einer aus der Source-Elektrode und der Drain-Elektrode des Dünnfilmtransistors verbunden ist.

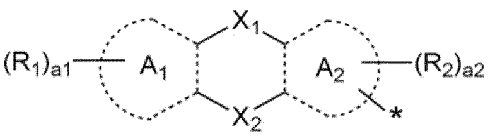
Revendications

1. Dispositif électroluminescent organique (10) comprenant :

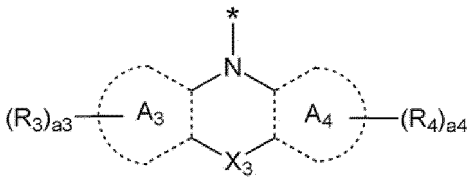
une première électrode (110) ;
une seconde électrode (190) qui fait face à la première électrode (110) ; et
une couche organique (150) entre la première électrode (110) et la seconde électrode (190) et comprenant une couche d'émission,
dans lequel la couche d'émission comprend un hôte et un dopant, l'hôte comprend un premier composé représenté par la Formule 1 et le dopant comprend un second composé représenté par la Formule 2A ou 2B, et
le premier composé n'est pas 1,3-di-9-carbazolylbenzène (mCP) :

Formule 1 $(CY_1)_{m1}$-$(L_1)_{b1}$-$(CY_2)_{m2}$

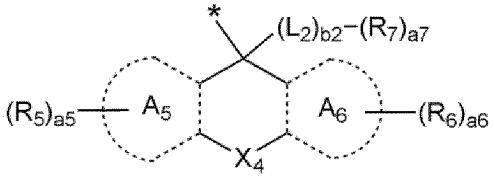
Formule 1-1



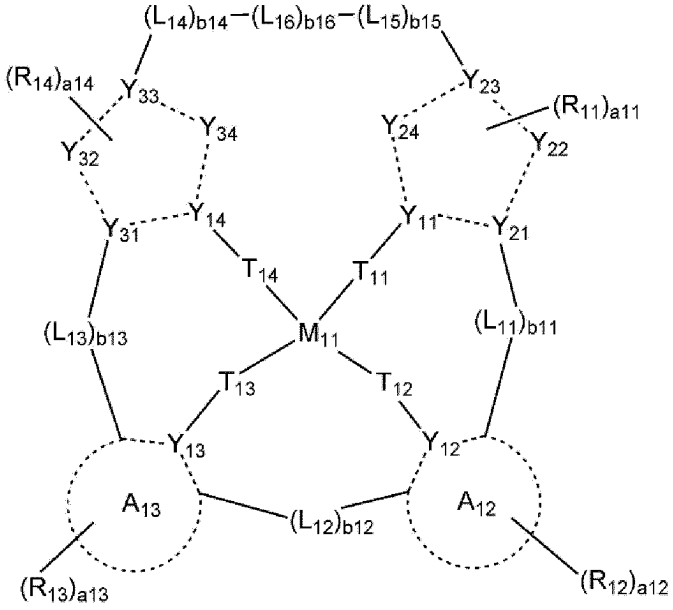
Formule 1-2



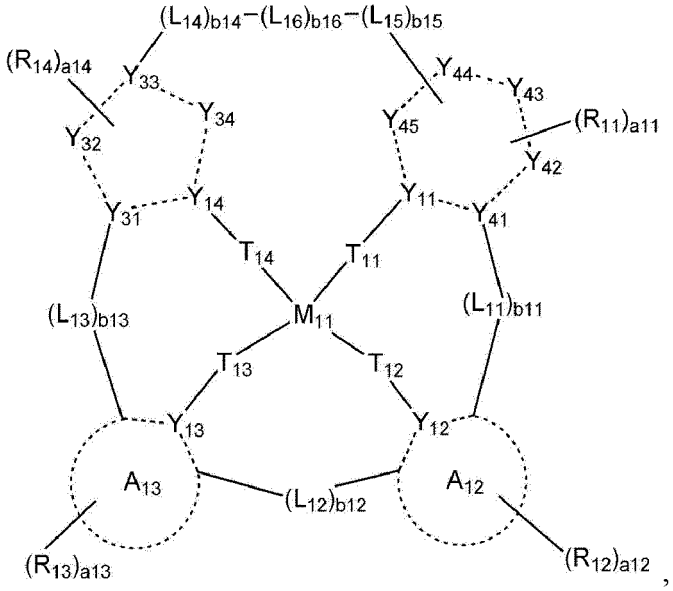
Formule 1-3



Formule 2A



Formule 2B



dans lequel, dans les Formules 1, 1-1, 1-2 et 1-3,

CY_1 et CY_2 sont chacun de manière indépendante un groupe représenté par l'une des Formules 1-1, 1-2 et 1-3,

m1 et m2 sont chacun de manière indépendante 0, 1 ou 2, dans lequel une somme de m1 et m2 est 2,

L_1 et L_2 sont chacun de manière indépendante sélectionnés parmi un groupe C_3-C_{10} cycloalkylène substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkylène substitué ou non substitué, un groupe C_3-C_{10} cycloalkénylène substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkénylène substitué ou non substitué, un

groupe C_6-C_{60} arylène substitué ou non substitué, un groupe C_1-C_{60} hétéroarylène substitué ou non substitué, un groupe polycyclique condensé non aromatique divalent substitué ou non substitué, un groupe hétéropolycyclique condensé non aromatique divalent substitué ou non substitué et -Si(Q_1)(Q_2)-,

b1 est un entier de 0 à 5,

b2 est un entier de 0 à 4,

X_1 à X_4 sont chacun de manière indépendante sélectionnés parmi une liaison simple, *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_8)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*', et *-Si(R_8)(R_9)-*',

les cycles A_1 à A_6 sont chacun de manière indépendante un groupe C_5-C_{60} carbocyclique ou un groupe C_2-C_{60} hétérocyclique,

R_1 à R_9 sont chacun de manière indépendante sélectionnés parmi hydrogène, deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amino, un groupe amidino, un groupe hydrazine, un groupe hydrazone, un groupe acide carboxylique ou un sel de celui-ci, un groupe acide sulfonique ou un sel de celui-ci, un groupe acide phosphorique ou un sel de celui-ci, un groupe C_1-C_{60} alkyle substitué ou non substitué, un groupe C_2-C_{60} alkényle substitué ou non substitué, un groupe C_2-C_{60} alkynyle substitué ou non substitué, un groupe C_1-C_{60} alcoxy substitué ou non substitué, un groupe C_3-C_{10} cycloalkyle substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkyle substitué ou non substitué, un groupe C_3-C_{10} cycloalkényle substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkényle substitué ou non substitué, un groupe C_6-C_{60} aryle substitué ou non substitué, un groupe C_6-C_{60} aryloxy substitué ou non substitué, un groupe C_6-C_{60} arylthio substitué ou non substitué, un groupe C_1-C_{60} hétéroaryle substitué ou non substitué, un groupe polycyclique condensé non aromatique monovalent substitué ou non substitué, un groupe hétéropolycyclique condensé non aromatique monovalent substitué ou non substitué, -Si(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1), -S(=O)$_2$(Q_1), -P(=O)(Q_1)(Q_2) et -P(=S)(Q_1)(Q_2),

a1 à a7 sont chacun de manière indépendante un entier de 1 à 8,

dans les Formules 2A et 2B,

M_{11} est sélectionné parmi platine (Pt), palladium (Pd), cuivre (Cu), argent (Ag), or (Au), rhodium (Rh), iridium (Ir), ruthénium (Ru), osmium (Os), titane (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb) et thulium (Tm),

A_{12} et A_{13} sont chacun de manière indépendante sélectionnés parmi un groupe C_5-C_{60} carbocyclique et un groupe C_1-C_{60} hétérocyclique,

Y_{11} à Y_{14} sont chacun de manière indépendante N ou C,

Y_{21} à Y_{24} sont chacun de manière indépendante N ou C,

Y_{31} à Y_{34} sont chacun de manière indépendante N ou C, et

Y_{41} à Y_{45} sont chacun de manière indépendante N ou C,

T_{11} à T_{14} sont chacun de manière indépendante sélectionnés parmi une liaison simple, O et S,

L_{11} à L_{13} sont chacun de manière indépendante sélectionnés parmi une liaison simple, *-O-*', *-S-*', *-C(R_{15})(R_{16})-*', *-C(R_{15})=*', *=C(R_{15})-*', *-C(R_{15})=C(R_{16})-*', *-C(=O)-*', *-C(=S)-*', *-C≡C-*', *-B(R_{15})-*', *-N(R_{15})-*', *-P(R_{15})-*', *-Si(R_{15})(R_{16})-*', *-P(=O)(R_{15})(R_{16})-*' et *-Ge(R_{15})(R_{16})-*',

b11 à b13 sont chacun de manière indépendante un entier de 0 à 3,

lorsque b11 est 0, Y_{21} ou Y_{41} n'est pas lié à A_{12}, lorsque b12 est 0, A_{12} et A_{13} ne sont pas liés l'un à l'autre, et lorsque b13 est 0, A_{13} et Y_{31} ne sont pas liés l'un à l'autre,

L_{14} à L_{16} sont chacun de manière indépendante sélectionnés parmi *-O-*', *-S-*', *-C(=O)-*', *-C(=S)-*', *-B(R_{17})-*', *-N(R_{17})-*', *-P(R_{17})-*', *-Si(R_{17})(R_{18})-*', *-P(=O)(R_{17})(R_{18})-*', *-Ge(R_{17})(R_{18})-*', un groupe C_2-C_{20} hydrocarbone divalent, un groupe C_5-C_{60} carbocyclique divalent et un groupe C_1-C_{60} hétérocyclique divalent,

b14 et b15 sont chacun de manière indépendante un entier de 1 à 5,

b16 est un entier de 0 à 5,

lorsque b16 est 0, L_{16} est une liaison simple,

R_{11} à R_{18} sont chacun de manière indépendante sélectionnés parmi hydrogène, deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amidino, un groupe hydrazino, un groupe hydrazono, un groupe C_1-C_{60} alkyle substitué ou non substitué, un groupe C_2-C_{60} alkényle substitué ou non substitué, un groupe C_2-C_{60} alkynyle substitué ou non substitué, un groupe C_1-C_{60} alcoxy substitué ou non substitué, un groupe C_3-C_{10} cycloalkyle substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkyle substitué ou non substitué, un groupe C_3-C_{10} cycloalkényle substitué ou non substitué, un groupe C_1-C_{10} hétérocycloalkényle substitué ou non substitué, un groupe C_6-C_{60} aryle substitué ou non substitué, un groupe C_6-C_{60} aryloxy substitué ou non substitué, un groupe C_6-C_{60} arylthio substitué ou non substitué, un groupe C_1-C_{60} hétéroaryle substitué ou non substitué, un groupe C_1-C_{60} hétéroaryloxy substitué ou non substitué, un groupe C_1-C_{60} hétéroarylthio substitué ou non substitué, un groupe polycyclique condensé non aromatique monovalent substitué ou non substitué, un groupe hétéropolycyclique condensé non aromatique monovalent substitué ou non substitué, -Si(Q_1)(Q_2)(Q_3), -B(Q_1)(Q_2), -N(Q_1)(Q_2), -P(Q_1)(Q_2), -C(=O)(Q_1), -S(=O)(Q_1),

$-S(=O)_2(Q_1)$, $-P(=O)(Q_1)(Q_2)$ et $-P(=S)(Q_1)(Q_2)$,
R_{15} et R_{11} ; R_{15} et R_{12} ; R_{15} et R_{13} ; ou R_{15} et R_{14} sont facultativement liés pour former un groupe C_5-C_{60} carbocyclique substitué ou non substitué ou un groupe C_1-C_{60} hétérocyclique substitué ou non substitué,
a11 à a14 sont chacun de manière indépendante un entier de 1 à 8,
* et *' indiquent chacun un site de liaison à un atome voisin,
au moins un substituant du groupe C_3-C_{10} cycloalkylène substitué, du groupe C_1-C_{10} hétérocycloalkylène substitué, du groupe C_3-C_{10} cycloalkénylène substitué, du groupe C_1-C_{10} hétérocycloalkénylène substitué, du groupe C_6-C_{60} arylène substitué, du groupe C_1-C_{60} hétéroarylène substitué, du groupe polycyclique condensé non aromatique divalent substitué, du groupe hétéropolycyclique condensé non aromatique divalent substitué, du groupe C_1-C_{60} alkyle substitué, du groupe C_2-C_{60} alkényle substitué, du groupe C_2-C_{60} alkynyle substitué, du groupe C_1-C_{60} alcoxy substitué, du groupe C_3-C_{10} cycloalkyle substitué, du groupe C_1-C_{10} hétérocycloalkyle substitué, du groupe C_3-C_{10} cycloalkényle substitué, du groupe C_1-C_{10} hétérocycloalkényle substitué, du groupe C_6-C_{60} aryle substitué, du groupe C_6-C_{60} aryloxy substitué, du groupe C_6-C_{60} arylthio substitué, du groupe C_1-C_{60} hétéroaryle substitué, du groupe polycyclique condensé non aromatique monovalent substitué et du groupe hétéropolycyclique condensé non aromatique monovalent substitué est sélectionné parmi :

deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amidino, un groupe hydrazino, un groupe hydrazono, un groupe C_1-C_{60} alkyle, un groupe C_2-C_{60} alkényle, un groupe C_2-C_{60} alkynyle et un groupe C_1-C_{60} alcoxy ;
un groupe C_1-C_{60} alkyle, un groupe C_2-C_{60} alkényle, un groupe C_2-C_{60} alkynyle et un groupe C_1-C_{60} alcoxy, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amidino, un groupe hydrazino, un groupe hydrazono, un groupe C_3-C_{10} cycloalkyle, un groupe C_1-C_{10} hétérocycloalkyle, un groupe C_3-C_{10} cycloalkényle, un groupe C_1-C_{10} hétérocycloalkényle, un groupe C_6-C_{60} aryle, un groupe C_6-C_{60} aryloxy, un groupe C_6-C_{60} arylthio, un groupe C_1-C_{60} hétéroaryle, un groupe polycyclique condensé non aromatique monovalent, un groupe hétéropolycyclique condensé non aromatique monovalent, $-Si(Q_{11})(Q_{12})(Q_{13})$, $-N(Q_{11})(Q_{12})$, $-B(Q_{11})(Q_{12})$, $-C(=O)(Q_{11})$, $-S(=O)_2(Q_{11})$ et $-P(=O)(Q_{11})(Q_{12})$;
un groupe C_3-C_{10} cycloalkyle, un groupe C_1-C_{10} hétérocycloalkyle, un groupe C_3-C_{10} cycloalkényle, un groupe C_1-C_{10} hétérocycloalkényle, un groupe C_6-C_{60} aryle, un groupe C_6-C_{60} aryloxy, un groupe C_6-C_{60} arylthio, un groupe C_1-C_{60} hétéroaryle, un groupe polycyclique condensé non aromatique monovalent, un groupe hétéropolycyclique condensé non aromatique monovalent, un groupe biphényle et un groupe terphényle ;
un groupe C_3-C_{10} cycloalkyle, un groupe C_1-C_{10} hétérocycloalkyle, un groupe C_3-C_{10} cycloalkényle, un groupe C_1-C_{10} hétérocycloalkényle, un groupe C_6-C_{60} aryle, un groupe C_6-C_{60} aryloxy, un groupe C_6-C_{60} arylthio, un groupe C_1-C_{60} hétéroaryle, un groupe polycyclique condensé non aromatique monovalent, un groupe hétéropolycyclique condensé non aromatique monovalent, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amidino, un groupe hydrazino, un groupe hydrazono, un groupe C_1-C_{60} alkyle, un groupe C_2-C_{60} alkényle, un groupe C_2-C_{60} alkynyle, un groupe C_1-C_{60} alcoxy, un groupe C_3-C_{10} cycloalkyle, un groupe C_1-C_{10} hétérocycloalkyle, un groupe C_3-C_{10} cycloalkényle, un groupe C_1-C_{10} hétérocycloalkényle, un groupe C_6-C_{60} aryle, un groupe C_6-C_{60} aryloxy, un groupe C_6-C_{60} arylthio, un groupe C_1-C_{60} hétéroaryle, un groupe polycyclique condensé non aromatique monovalent, un groupe hétéropolycyclique condensé non aromatique monovalent à l'exclusion d'un groupe carbazolyle, $-Si(Q_{21})(Q_{22})(Q_{23})$, $-N(Q_{21})(Q_{22})$, $-B(Q_{21})(Q_{22})$, $-C(=O)(Q_{21})$, $-S(=O)_2(Q_{21})$ et $-P(=O)(Q_{21})(Q_{22})$; et
$-Si(Q_{31})(Q_{32})(Q_{33})$, $-N(Q_{31})(Q_{32})$, $-B(Q_{31})(Q_{32})$, $-C(=O)(Q_{31})$, $-S(=O)_2(Q_{31})$ et $-P(=O)(Q_{31})(Q_{32})$, et
Q_1 à Q_3, Q_{11} à Q_{13}, Q_{21} à Q_{23} et Q_{31} à Q_{33} sont chacun de manière indépendante sélectionnés parmi hydrogène, deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amidino, un groupe hydrazino, un groupe hydrazono, un groupe C_1-C_{60} alkyle, un groupe C_2-C_{60} alkényle, un groupe C_2-C_{60} alkynyle, un groupe C_1-C_{60} alcoxy, un groupe C_3-C_{10} cycloalkyle, un groupe C_1-C_{10} hétérocycloalkyle, un groupe C_3-C_{10} cycloalkényle, un groupe C_1-C_{10} hétérocycloalkényle, un groupe C_6-C_{60} aryle, un groupe C_6-C_{60} aryle substitué par un groupe C_1-C_{60} alkyle, un groupe C_6-C_{60} aryle substitué par un groupe C_6-C_{60} aryle, un groupe terphényle, un groupe C_1-C_{60} hétéroaryle, un groupe C_1-C_{60} hétéroaryle substitué par un groupe C_1-C_{60} alkyle, un groupe C_1-C_{60} hétéroaryle substitué par un groupe C_6-C_{60} aryle, un groupe polycyclique condensé non aromatique monovalent et un groupe hétéropolycyclique condensé non aromatique monovalent.

2. Dispositif électroluminescent organique (10) selon la revendication 1, dans lequel :
L_1 et L_2 dans les Formules 1, 1-1, 1-2 et 1-3 sont chacun de manière indépendante sélectionnés parmi :

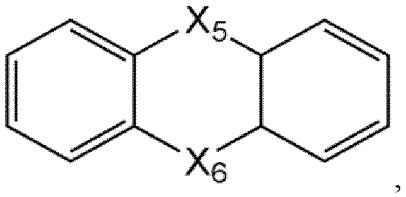
un groupe phénylène, un groupe naphtylène, un groupe fluorénylène, un groupe spiro-fluorénylène, un groupe benzofluorène, un groupe dibenzofluorène, un groupe phénanthrénylène, un groupe anthracénylène, un groupe pyrénylène, un groupe chrysénylène, un groupe pyridinylène, un groupe pyrazinylène, un groupe pyrimidinylène, un groupe pyridazinylène, un groupe quinolinylène, un groupe isoquinolinylène, un groupe quinoxalinylène, un groupe quinazolinylène, un groupe carbazolylène et un groupe triazinylène ;
un groupe phénylène, un groupe naphtylène, un groupe fluorénylène, un groupe spiro-fluorénylène, un groupe benzofluorénylène, un groupe dibenzofluorénylène, un groupe phénanthrénylène, un groupe anthracénylène, un groupe pyrénylène, un groupe chrysénylène, un groupe pyridinylène, un groupe pyrazinylène, un groupe pyrimidinylène, un groupe pyridazinylène, un groupe quinolinylène, un groupe isoquinolinylène, un groupe quinoxalinylène, un groupe quinazolinylène, un groupe carbazolylène et un groupe triazinylène, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, - Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amino, un groupe amidino, un groupe hydrazine, un groupe hydrazone, un groupe acide carboxylique ou un sel de celui-ci, un groupe acide sulfonique ou un sel de celui-ci, un groupe acide phosphorique ou un sel de celui-ci, un groupe C_1-C_{20} alkyle, un groupe C_1-C_{20} alcoxy, un groupe phényle, un groupe biphényle, un groupe terphényle, un groupe naphtyle, un groupe fluorényle, un groupe spiro-fluorényle, un groupe benzofluorényle, un groupe dibenzofluorényle, un groupe phénanthrényle, un groupe anthracényle, un groupe pyrényle, un groupe chrysényle, un groupe pyridinyle, un groupe pyrazinyle, un groupe pyrimidinyle, un groupe pyridazinyle, un groupe isoindolyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle et un groupe triazinyle ; et
$-Si(Q_4)(Q_5)-$, et
Q_4 et Q_5 sont chacun de manière indépendante sélectionnés parmi :

un groupe C_1-C_{10} alkyle, un groupe C_1-C_{10} alcoxy et un groupe phényle ; et
un groupe phényle, un groupe biphényle, un groupe terphényle et un groupe naphtyle, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, - Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe C_1-C_{20} alkyle, un groupe C_1-C_{20} alcoxy, un groupe phényle, un groupe biphényle, un groupe terphényle et un groupe naphtyle.

3. Dispositif électroluminescent organique (10) selon la revendication 1 ou la revendication 2, dans lequel :

A_1 à A_6 dans les Formules 1-1, 1-2 et 1-3 sont chacun de manière indépendante sélectionnés parmi un cycle benzène, un cycle naphtalène, un cycle pyridine, un cycle pyrimidine, un cycle pyrazine, un cycle pyridazine, un cycle triazine, un cycle quinoline, un cycle isoquinoline, un cycle quinoxaline, un cycle quinazoline et un cycle représenté par la Formule 4 :

Formule 4



,

dans lequel, dans la Formule 4,
X_5 et X_6 sont chacun de manière indépendante sélectionnés parmi *-O-*, *-S-*, *-C(R_8)(R_9)-*', *-C(=O)-*', *-B(R_8)(R_9)-*', *-N(R_8)-*', *-P(R_8)-*' et *-Si(R_8)(R_9)-*' et
R_8 et R_9 sont les mêmes que décrit en connexion avec les Formules 1, 1-1, 1-2 et 1-3.

4. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 3, dans lequel :
R_1 à R_9 dans les Formules 1-1, 1-2 et 1-3 sont chacun de manière indépendante sélectionnés parmi :

hydrogène, deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amino, un groupe amidino, un groupe hydrazine, un groupe hydrazone, un groupe acide carboxylique ou un sel de celui-ci, un groupe acide sulfonique ou un sel de celui-ci, un groupe acide phosphorique ou un sel de celui-ci, un groupe C_1-C_{60} alkyle, un groupe C_2-C_{60} alkényle, un groupe C_2-C_{60} alkynyle, un groupe C_1-C_{60} alcoxy, un groupe phényle, un groupe naphtyle, un groupe fluorényle, un groupe pyrényle, un groupe phénalényle, un groupe phénanthrényle, un groupe anthracényle, un groupe fluoranthényle, un groupe triphénylényle, un groupe

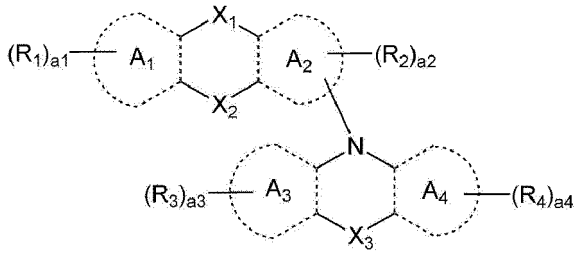
pyrazolyle, un groupe imidazolyle, un groupe benzimidazolyle, un groupe pyridinyle, un groupe pyrimidyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe benzoquinolinyle, un groupe naphtyridinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle, un groupe phénanthridinyle, un groupe acridinyle, un groupe phénanthrolinyle, un groupe phénazinyle, un groupe triazinyle, un groupe dibenzofuranyle, un groupe dibenzothiophényle, un groupe biphényle et un groupe terphényle ;
un groupe phényle, un groupe naphtyle, un groupe fluorényle, un groupe pyrényle, un groupe phénalényle, un groupe phénanthrényle, un groupe anthracényle, un groupe fluoranthényle, un groupe triphénylényle, un groupe pyrazolyle, un groupe imidazolyle, un groupe benzimidazolyle, un groupe pyridinyle, un groupe pyrimidyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe benzoquinolinyle, un groupe naphtyridinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle, un groupe phénanthridinyle, un groupe acridinyle, un groupe phénanthrolinyle, un groupe phénazinyle, un groupe triazinyle, un groupe dibenzofuranyle, un groupe dibenzothiophényle, un groupe biphényle et un groupe terphényle, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe méthyle, un groupe éthyle, un groupe propyle, un groupe isobutyle, un groupe sec-butyle, un groupe ter-butyle, un groupe pentyle, un groupe isoamyle, un groupe hexyle, un groupe C_1-C_{60} alcoxy, un groupe cyclopentyle, un groupe cyclohexyle, un groupe cycloheptyle, un groupe cyclopentényle, un groupe cyclohexényle, un groupe phényle, un groupe naphtyle, un groupe fluorényle, un groupe pyrényle, un groupe phénalényle, un groupe phénanthrényle, un groupe anthracényle, un groupe fluoranthényle, un groupe triphénylényle, un groupe pyrazolyle, un groupe imidazolyle, un groupe benzimidazolyle, un groupe pyridinyle, un groupe pyrimidyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe benzoquinolinyle, un groupe naphtyridinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle, un groupe phénanthridinyle, un groupe acridinyle, un groupe phénanthrolinyle, un groupe phénazinyle, un groupe triazinyle, un groupe dibenzofuranyle, un groupe dibenzothiophényle, un groupe biphényle et un groupe terphényle ; et
$-Si(Q_4)(Q_5)(Q_6)$ et $-P(=O)(Q_4)(Q_5)$, et
Q_4 à Q_6 sont chacun de manière indépendante sélectionnés parmi :

un groupe C_1-C_{10} alkyle, un groupe C_1-C_{10} alcoxy et un groupe phénylène ; et
un groupe phényle, un groupe biphényle, un groupe terphényle et un groupe naphtyle, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, - Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe C_1-C_{20} alkyle, un groupe C_1-C_{20} alcoxy, un groupe phényle, un groupe biphényle, un groupe terphényle et un groupe naphtyle.

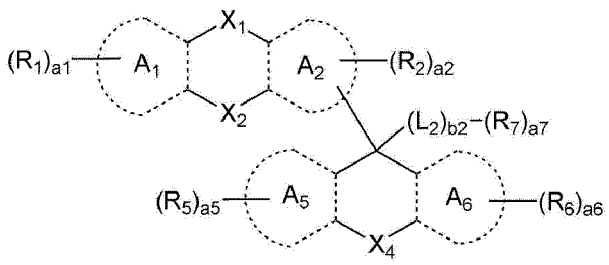
5. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 4, dans lequel :

le premier composé est un composé représenté par l'une des Formules 1A, 1B et 1C :

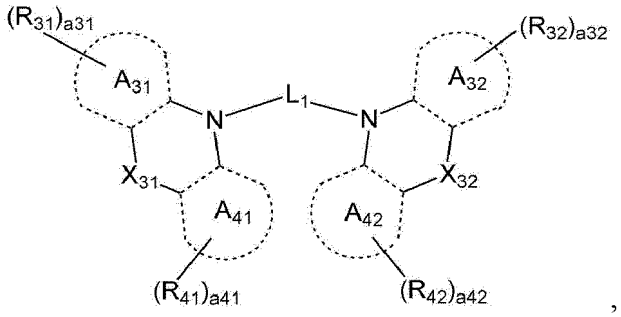
Formule 1A



Formule 1B



Formule 1C



,

dans lequel, dans les Formules 1A, 1B et 1C,

X_1 à X_4, A_1 à A_6, L_1, L_2, b2, R_1 à R_7 et a1 à a7 sont les mêmes que décrit en connexion avec les Formules 1, 1-1, 1-2 et 1-3,

X_{31} et X_{32} sont chacun de manière indépendante les mêmes que décrit en connexion avec X_3 dans les Formules 1, 1-1, 1-2 et 1-3,

A_{31} et A_{32} sont chacun de manière indépendante les mêmes que décrit en connexion avec A_3 dans les Formules 1, 1-1, 1-2 et 1-3,

A_{41} et A_{42} sont chacun de manière indépendante les mêmes que décrit en connexion avec A_4 dans les Formules 1, 1-1, 1-2 et 1-3,

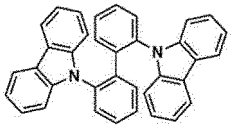
R_{31} et R_{32} sont chacun de manière indépendante les mêmes que décrit en connexion avec R_3 dans les Formules 1, 1-1, 1-2 et 1-3,

R_{41} et R_{42} sont chacun de manière indépendante les mêmes que décrit en connexion avec R_4 dans les Formules 1, 1-1, 1-2 et 1-3,

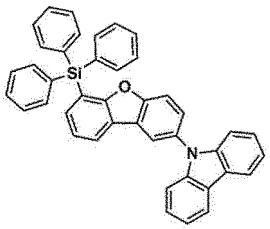
a31 et a32 sont chacun de manière indépendante les mêmes que décrit en connexion avec a3 dans les Formules 1, 1-1, 1-2 et 1-3, et

a41 et a42 sont chacun de manière indépendante les mêmes que décrit en connexion avec a4 dans les Formules 1, 1-1, 1-2 et 1-3.

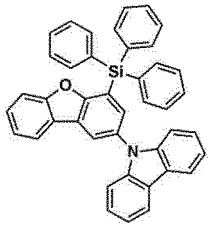
6. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 5, dans lequel :
le premier composé est sélectionné parmi les Composés BH2 à BH28 :



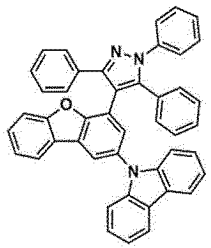
BH2



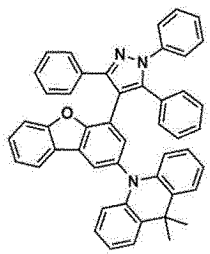
BH3



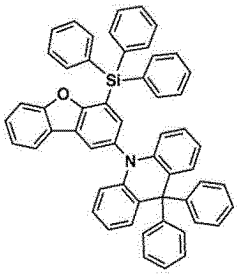
BH4



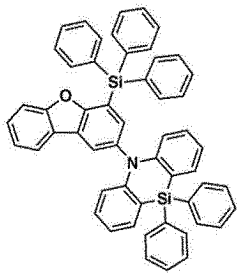
BH5



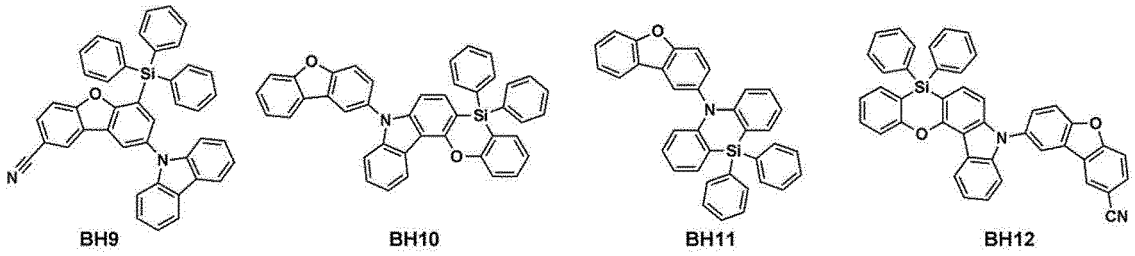
BH6



BH7



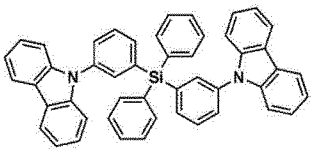
BH8

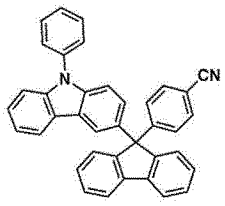

BH9

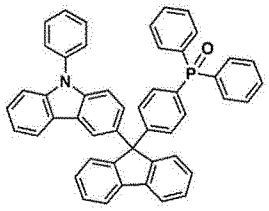
BH10

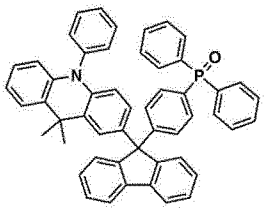
BH11

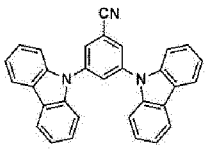
BH12

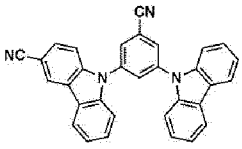

BH13

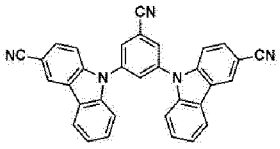

BH14

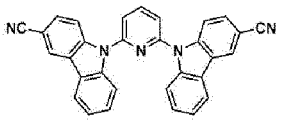

BH15

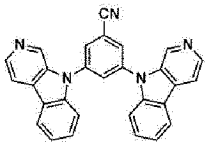

BH16

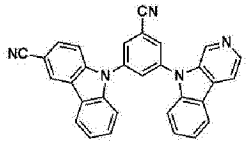

BH17

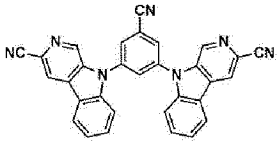

BH18

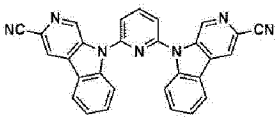

BH19

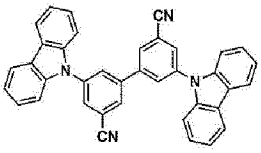

BH20

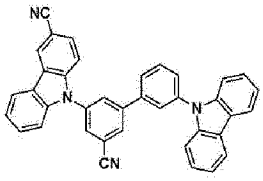

BH21

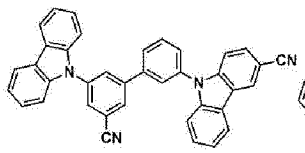

BH22

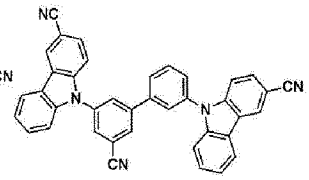

BH23


BH24


BH25


BH26

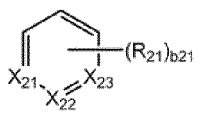

BH27

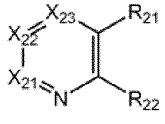

BH28

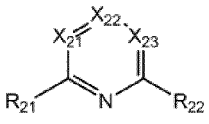
7. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 6, dans lequel : M_{11} dans les Formules 2A et 2B est sélectionné parmi Pt, Pd, Cu, Ag et Au.

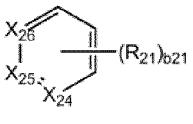
8. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 7, dans lequel :

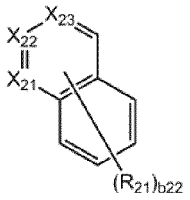
A_{12} et A_{13} dans les Formules 2A et 2B sont chacun de manière indépendante représentés par une formule sélectionnée parmi les Formules 2-1 à 2-43 :

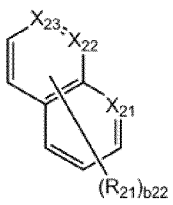

2-1


2-2

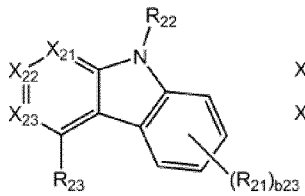

2-3


2-4

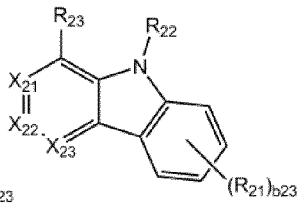

2-5



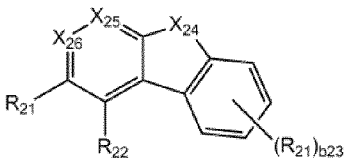
2-6



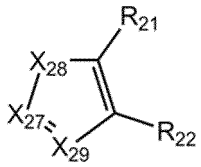
2-7



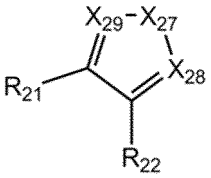
2-8



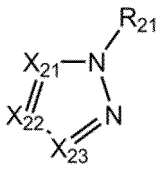
2-9



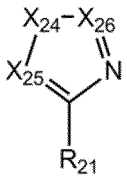
2-10



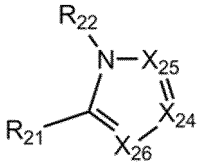
2-11



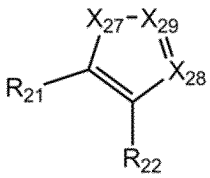
2-12



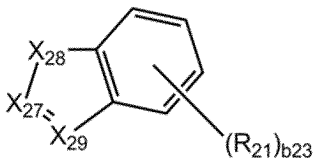
2-13



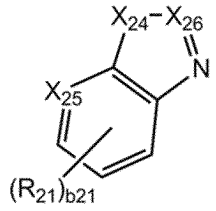
2-14



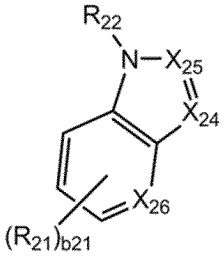
2-15



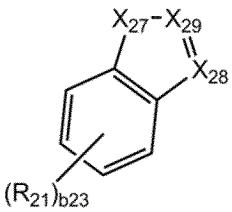
2-16



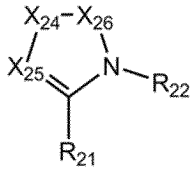
2-17



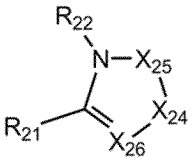
2-18



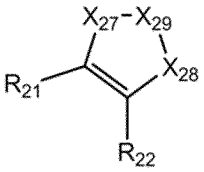
2-19



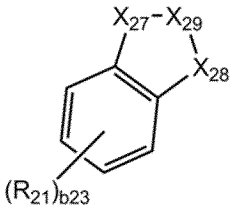
2-20



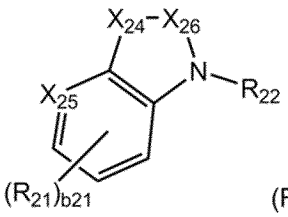
2-21



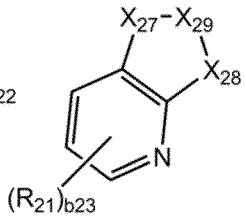
2-22



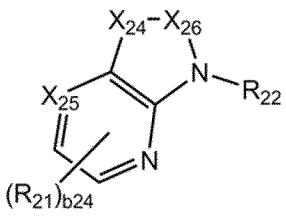
2-23



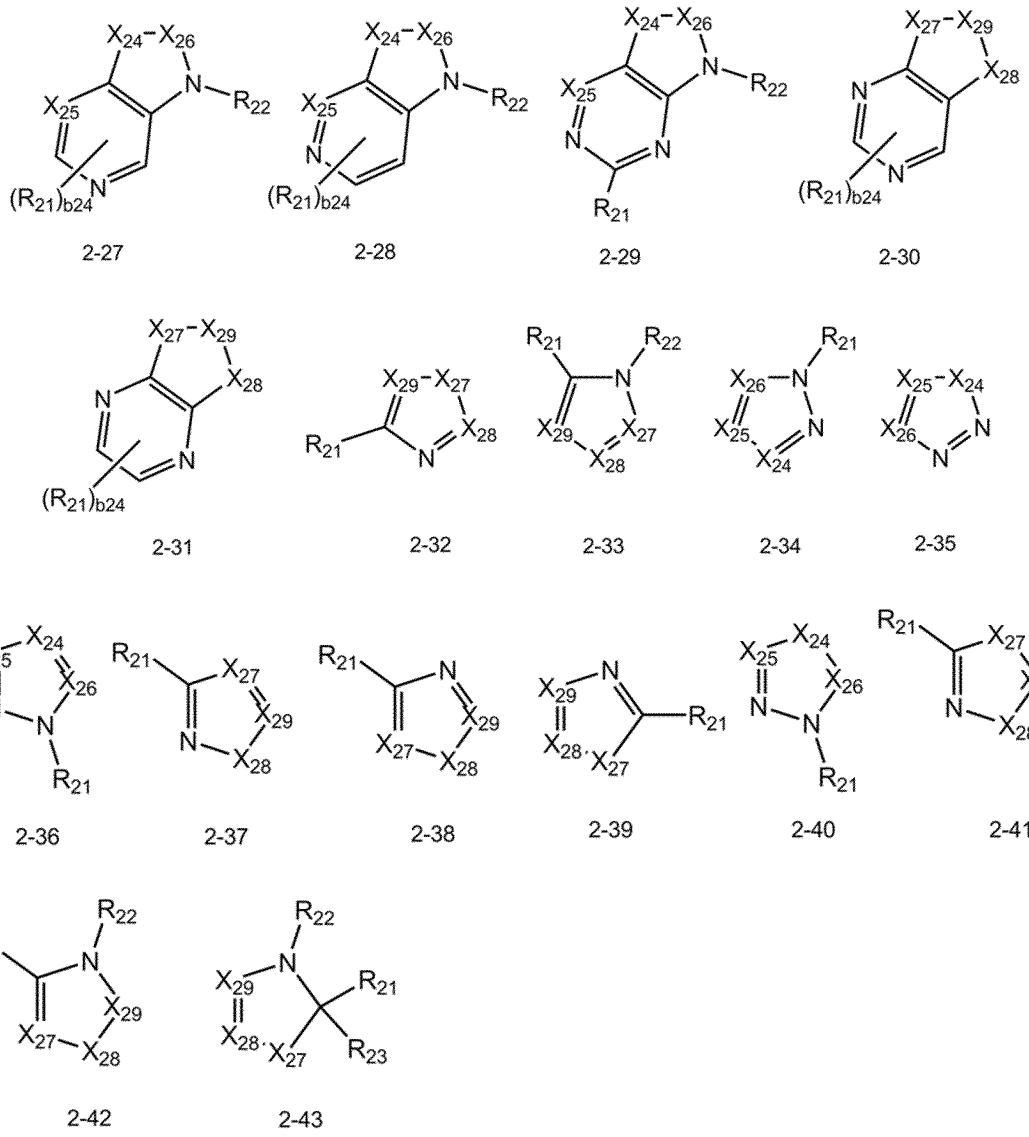
2-24



2-25



2-26



2-27 2-28 2-29 2-30

2-31 2-32 2-33 2-34 2-35

2-36 2-37 2-38 2-39 2-40 2-41

2-42 2-43

,

dans lequel, dans les Formules 2-1 à 2-43,

X_{21} à X_{23} sont chacun de manière indépendante sélectionnés parmi $C(R_{24})$ et C-*, dans lequel au moins deux de X_{21} à X_{23} sont chacun C-*,

X_{24} est N-* et X_{25} et X_{26} sont chacun de manière indépendante sélectionnés parmi $C(R_{24})$ et C-*, dans lequel au moins l'un de X_{25} et X_{26} est C-*,

X_{27} et X_{28} sont chacun de manière indépendante sélectionnés parmi N, $N(R_{25})$ et N-* et X_{29} est sélectionné parmi $C(R_{24})$ et C-*, dans lequel i) au moins l'un de X_{27} et X_{28} est N-* et X_{29} est C-*, ou ii) X_{27} et X_{28} sont chacun N-* et X_{29} est $C(R_{24})$,

R_{21} à R_{25} sont chacun de manière indépendante les mêmes que décrit en connexion avec R_{11} dans la Formule 1,

b21 est sélectionné parmi 1, 2 et 3,

b22 est sélectionné parmi 1, 2, 3, 4 et 5,

b23 est sélectionné parmi 1, 2, 3 et 4,

b24 est sélectionné parmi 1 et 2 et

* indique un site de liaison à un atome voisin.

9. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 8, dans lequel,

dans les Formules 2A et 2B,

Y_{11}, Y_{12} et Y_{13} sont chacun C et Y_{14} est N ;

Y_{11}, Y_{12} et Y_{14} sont chacun C et Y_{13} est N ;

Y_{11}, Y_{13} et Y_{14} sont chacun C et Y_{12} est N ;
Y_{12}, Y_{13} et Y_{14} sont chacun C et Y_{11} est N ;
Y_{11} et Y_{14} sont chacun C et Y_{12} et Y_{13} sont chacun N ;
Y_{11} et Y_{14} sont chacun N et Y_{12} et Y_{13} sont chacun C ;
Y_{11} et Y_{12} sont chacun C et Y_{13} et Y_{14} sont chacun N ;
Y_{11} et Y_{12} sont chacun N et Y_{13} et Y_{14} sont chacun C ;
Y_{11} et Y_{13} sont chacun C et Y_{12} et Y_{14} sont chacun N ; ou
Y_{11} et Y_{13} sont chacun N et Y_{12} et Y_{14} sont chacun C.

10. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 9, dans lequel,

dans les Formules 2A et 2B,
L_{14} et L_{15} sont chacun de manière indépendante sélectionnés parmi *-O-*', *-S-*', *-N(R_{19})-*', un groupe C_2-C_{20} alkylène, un groupe C_2-C_{20} alkénylène et un groupe C_2-C_{20} alkynylène,
R_{19} est sélectionné parmi :

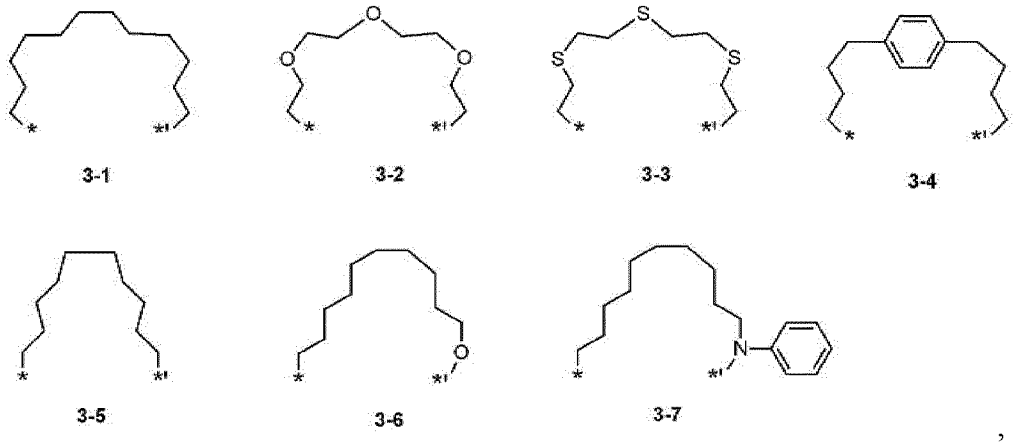
un groupe phényle, un groupe biphényle, un groupe terphényle, un groupe naphtyle, un groupe fluorényle, un groupe spiro-fluorényle, un groupe benzofluorényle, un groupe dibenzofluorényle, un groupe phénanthrényle, un groupe anthracényle, un groupe pyrényle, un groupe chrysényle, un groupe pyridinyle, un groupe pyrazinyle, un groupe pyrimidinyle, un groupe pyridazinyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle et un groupe triazinyle ; et
un groupe phényle, un groupe biphényle, un groupe terphényle, un groupe naphtyle, un groupe fluorényle, un groupe spiro-fluorényle, un groupe benzofluorényle, un groupe dibenzofluorényle, un groupe phénanthrényle, un groupe anthracényle, un groupe pyrényle, un groupe chrysényle, un groupe pyridinyle, un groupe pyrazinyle, un groupe pyrimidinyle, un groupe pyridazinyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle et un groupe triazinyle, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amino, un groupe amidino, un groupe hydrazine, un groupe hydrazone, un acide carboxylique ou un sel de celui-ci, un groupe acide sulfonique ou un sel de celui-ci, un groupe acide phosphorique ou un sel de celui-ci, un groupe C_1-C_{20} alkyle, un groupe C_1-C_{20} alcoxy, un groupe phényle, un groupe biphényle, un groupe terphényle, un groupe naphtyle, un groupe azulényle, un groupe fluorényle, un groupe spiro-fluorényle, un groupe benzofluorényle, un groupe dibenzofluorényle, un groupe phénanthrényle, un groupe anthracényle, un groupe pyrényle, un groupe chrysényle, un groupe pyridinyle, un groupe pyrazinyle, un groupe pyrimidinyle, un groupe pyridazinyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle et un groupe triazinyle, et
L_{16} est sélectionné parmi :

un groupe phénylène, un groupe naphtylène, un groupe fluorénylène, un groupe spiro-fluorénylène, un groupe benzofluorène, un groupe dibenzofluorène, un groupe phénanthrénylène, un groupe anthracénylène, un groupe pyrénylène, un groupe chrysénylène, un groupe pyridinylène, un groupe pyrazinylène, un groupe pyrimidinylène, un groupe pyridazinylène, un groupe quinolinylène, un groupe isoquinolinylène, un groupe quinoxalinylène, un groupe quinazolinylène, un groupe carbazolylène et un groupe triazinylène ; et
un groupe phénylène, un groupe naphtylène, un groupe fluorénylène, un groupe spiro-fluorénylène, un groupe benzofluorénylène, un groupe dibenzofluorénylène, un groupe phénanthrénylène, un groupe anthracénylène, un groupe pyrénylène, un groupe chrysénylène, un groupe pyridinylène, un groupe pyrazinylène, un groupe pyrimidinylène, un groupe pyridazinylène, un groupe quinolinylène, un groupe isoquinolinylène, un groupe quinoxalinylène, un groupe quinazolinylène, un groupe carbazolylène et un groupe triazinylène, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, - Cl, -Br, -I, un groupe hydroxyle, un groupe cyano, un groupe nitro, un groupe amino, un groupe amidino, un groupe hydrazine, un groupe hydrazone, un groupe acide carboxylique ou un sel de celui-ci, un groupe acide sulfonique ou un sel de celui-ci, un groupe acide phosphorique ou un sel de celui-ci, un groupe C_1-C_{20} alkyle, un groupe C_1-C_{20} alcoxy, un groupe phényle, un groupe biphényle, un groupe terphényle, un groupe naphtyle, un groupe fluorényle, un groupe spiro-fluorényle, un groupe benzofluorényle, un groupe dibenzofluorényle, un groupe phénanthrényle, un groupe anthracényle, un groupe pyrényle, un groupe chrysényle, un groupe pyridinyle, un groupe pyrazinyle, un groupe pyrimidinyle, un groupe

pyridazinyle, un groupe isoindolyle, un groupe quinolinyle, un groupe isoquinolinyle, un groupe quinoxalinyle, un groupe quinazolinyle, un groupe carbazolyle et un groupe triazinyle.

11. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 10, dans lequel :

une fraction représentée par *-$(L_{14})_{b14}$-$(L_{16})_{b16}$-$(L_{15})_{b15}$-*' dans les Formules 2A et 2B est représentée par une formule sélectionnée parmi les Formules 3-1 à 3-7 :



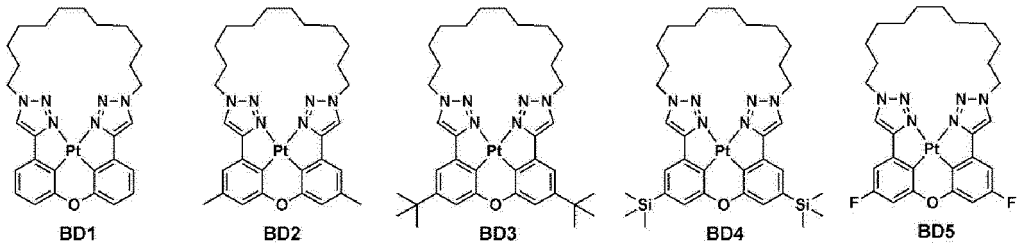
,

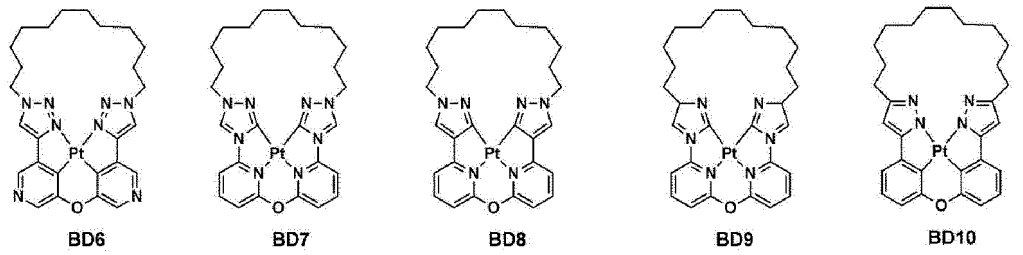
dans lequel, dans les Formules 3-1 à 3-7,
* et *' indiquent chacun un site de liaison à un atome voisin.

12. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 11, dans lequel :
R_{11} à R_{19} dans les Formules 2A et 2B sont chacun de manière indépendante sélectionnés parmi :

hydrogène, deutérium, -F, -Cl, -Br, -I, un groupe cyano, un groupe méthyle, un groupe éthyle, un groupe n-propyle, un groupe isopropyle, un groupe n-butyle, un groupe isobutyle, un groupe sec-butyle et un groupe tert-butyle ;
un groupe méthyle, un groupe éthyle, un groupe n-propyle, un groupe isopropyle, un groupe n-butyle, un groupe isobutyle, un groupe sec-butyle et un groupe tert-butyle, chacun substitué par au moins un groupe sélectionné parmi deutérium, -F, -Cl, -Br, -I et un groupe cyano ; et
un groupe phényle, un groupe naphtyle et un groupe pyridinyle.

13. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 12, dans lequel :
le second composé est sélectionné parmi les Composés BD1 à BD25, où Ph dans les Composés BD1 à BD25 représente un groupe phényle :



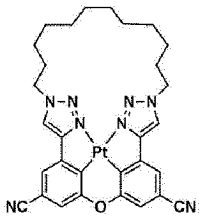

BD6

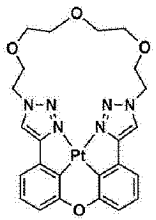
BD7

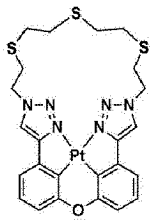
BD8

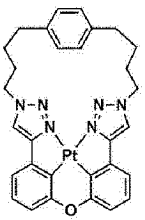
BD9

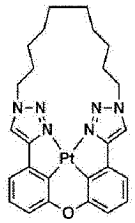
BD10

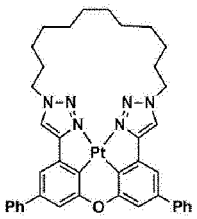

BD11

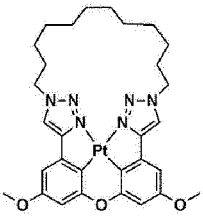

BD12

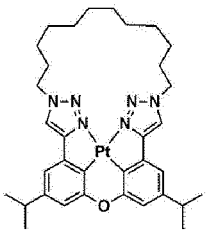

BD13

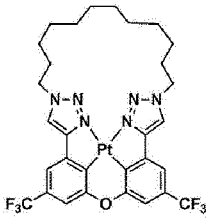

BD14

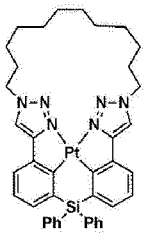

BD15

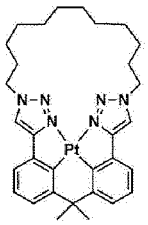

BD16

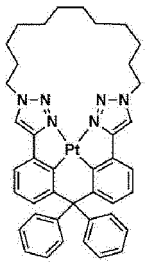

BD17

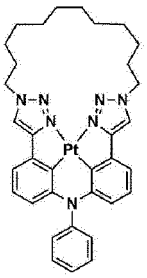

BD18

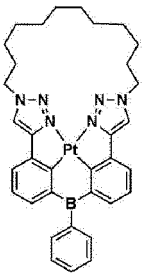

BD19

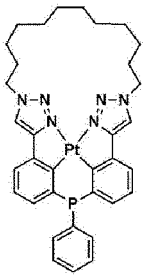

BD20


BD21


BD22


BD23


BD24


BD25

14. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 13, dans lequel :

l'hôte comprend en outre un composé contenant de l'oxyde de phosphine, et
le composé contenant de l'oxyde de phosphine est différent du premier composé.

15. Dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 14, dans lequel :

la première électrode (110) est une anode,
la seconde électrode (190) est une cathode, et
la couche organique (150) comprend en outre une région de transport de trous entre la première électrode (110) et la couche d'émission et une région de transport d'électrons entre la couche d'émission et la seconde électrode (190),
la région de transport de trous comprend au moins une couche sélectionnée parmi une couche d'injection de trous, une couche de transport de trous, une couche tampon, une couche auxiliaire d'émission et une couche de blocage d'électrons, et
la région de transport d'électrons comprend au moins une couche sélectionnée parmi une couche de blocage de trous, une couche de transport d'électrons et une couche d'injection d'électrons.

16. Dispositif électroluminescent organique (10) selon la revendication 15, dans lequel :

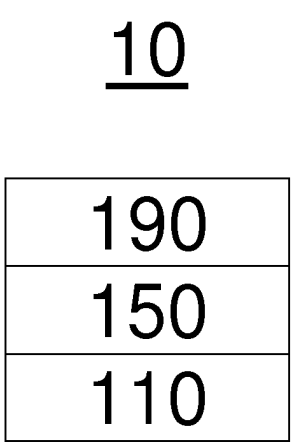
la région de transport de trous comprend au moins une couche parmi une couche d'injection de trous et une couche de transport de trous, et
au moins une couche parmi la couche d'injection de trous et la couche de transport de trous comprend un dopant p, ou
la région de transport de trous comprend un unique film comprenant un dopant p.

17. Dispositif électroluminescent organique (10) selon la revendication 15 ou la revendication 16, dans lequel :

la région de transport d'électrons comprend une couche de blocage de trous, et
la couche de blocage de trous comprend un composé contenant de l'oxyde de phosphine ou un composé contenant du silyle.

18. Appareil d'affichage à écran plat comprenant :

un transistor à film mince comprenant une électrode de source, une électrode de drain et une couche active ; et
un dispositif électroluminescent organique (10) selon l'une quelconque des revendications 1 à 17,
dans lequel la première électrode (110) du dispositif électroluminescent organique (10) est connectée électriquement à une électrode parmi l'électrode de source et l'électrode de drain du transistor à film mince.


10
190
150
110

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 2005227112 A1 **[0004]**
- WO 2010079051 A1 **[0004]**